Proceedings of the American Association for the Advancement ...

American Association for the Advancement of Science

PROCEEDINGS

OF

The American Association

FOR THE

ADVANCEMENT OF SCIENCE,

FIFTY-FOURTH MEETING

HELD AT

PHILADELPHIA, PA.

DECEMBER 27–31, 1904.

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L. O. HOWARD,

Permanent Secretary

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10. *Committee on the Study of Blind Vertebrates.*

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[1] All Committees are expected to present their reports to the Council not later than the third day of the meeting. Committees sending their reports to the Permanent Secretary one month before a meeting can have them printed for use at the meeting.

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11. *Committee on the Teaching of Anthropology in America.*

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12. *Committee on the Relations of the Journal "Science" with the Association.*

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13. *Committee on the Relations of Plants and Climate.*

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14. *Committee on the Atomic Weight of Thorium.*

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15. *Committee on the Velocity of Light.*

W. S. Franklin, *Chairman*, E. F. Nichols.

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Meeting.	Date.	Place.	Chairman.	Secretary.	Assistant Secretary.	Treasurer.
1st	April 2, 1840,	Philadelphia,	Edw. Hitchcock,*	L. C. Beck,*		
2d	April 5, 1841,	Philadelphia,	Benj. Silliman,*	L. C. Beck,*	B. Silliman, Jr.,* C. B. Trego,*	
3d	April 25, 1842,	Boston,	S. G. Morton,*	C. T. Jackson,*	J. D. Whitney,* M. B. Williams,*	
4th	April 26, 1843,	Albany,	Henry D. Rogers,*	B. Silliman, Jr.,*		John Locke.*
5th	May 8, 1844,	Washington,	John Locke,*	B. Silliman, Jr.,* O. P. Hubbard,		Douglas Houghton.*
6th	April 30, 1845,	New Haven,	Wm. B. Rogers,*	B. Silliman, Jr.,* J. Law. Smith,*		Douglas Houghton.*
7th	Sept. 2, 1846,	New York,	C. T. Jackson,*	B. Silliman, Jr.,*		E. C. Herrick.*
8th	Sept. 20, 1847,	Boston,	Wm. B. Rogers,*†	Jeffries Wyman,*		B. Silliman, Jr.*

* Deceased.

† Professor Rogers, as chairman of this last meeting, called the first meeting of the new Association to order and presided until it was fully organized by the adoption of a constitution. As he was thus the first presiding officer of the new Association, it was directed at the Hartford meeting that his name be placed at the head of the Past Presidents of the American Association for the Advancement of Science.

Meetings	Place	Date	Members in attendance	Number of members
1	Philadelphia	Sept. 20, 1848	?	461
2	Cambridge	Aug. 14, 1849	?	540
3	Charleston	Mar. 12, 1850	?	622
4	New Haven	Aug. 19, 1850	?	704
5	Cincinnati	May 5, 1851	87	800
6	Albany	Aug. 19, 1851	194	769
7	Cleveland	July 28, 1853	?	940
8	Washington	April 26, 1854	168	1004
9	Providence	Aug. 15, 1855	166	605
10	2d Albany	Aug. 20, 1856	381	722
11	Montreal	Aug. 12, 1857	351	946
12	Baltimore	April 28, 1858	190	962
13	Springfield	Aug. 3, 1859	190	862
14	Newport	Aug. 1, 1860	135	644
15	Buffalo	Aug. 15, 1866	79	637
16	Burlington	Aug. 21, 1867	73	415
17	Chicago	Aug. 5, 1868	259	686
18	Salem	Aug. 18, 1869	244	511
19	Troy	Aug. 17, 1870	188	536
20	Indianapolis	Aug. 16, 1871	196	668
21	Dubuque	Aug. 15, 1872	164	610
22	Portland	Aug. 20, 1873	195	670
23	Hartford	Aug. 12, 1874	224	722
24	Detroit	Aug. 11, 1875	165	807
25	2d Buffalo	Aug. 23, 1876	215	867
26	Nashville	Aug. 29, 1877	173	953
27	St. Louis	Aug. 21, 1878	134	962
28	Saratoga	Aug. 27, 1879	256	1030
29	Boston	Aug. 25, 1880	997	1555
30	2d Cincinnati	Aug. 17, 1881	500	1699
31	2d Montreal	Aug. 23, 1882	937	1922
32	Minneapolis	Aug. 15, 1883	328	2033
33	2d Philadelphia	Sept. 3, 1884	1261*	1981
34	Ann Arbor	Aug. 26, 1885	364	1956
35	3d Buffalo	Aug. 18, 1886	445	1886
36	New York	Aug. 10, 1887	729	1956
37	2d Cleveland	Aug. 14, 1888	342	1964
38	Toronto	Aug. 26, 1889	424	1952
39	2d Indianapolis	Aug. 19, 1890	364	1944
40	2d Washington	Aug. 19, 1891	653†	2054
41	Rochester	Aug. 17, 1892	456	2037
42	Madison	Aug. 17, 1893	290	1939
43	Brooklyn	Aug. 15, 1894	488	1802
44	2d Springfield	Aug. 28, 1895	368	1913
45	4th Buffalo	Aug. 24, 1896	333	1890
46	2d Detroit	Aug. 9, 1897	283‡	1782
47	2d Boston	Aug. 22, 1898	903	1729
48	Columbus	Aug. 21, 1899	353	1721
49	2d New York	June 25, 1900	434	1925
50	Denver	Aug. 24, 1901	311	2703
51	Pittsburg	June 28 to July 3, 1902	435	3473
52	3d Washington	Dec. 27, 1902, to Jan. 2, 1903	975	3596
53	2d St. Louis	Dec. 28, 1903, to Jan. 2, 1904	385	4 75
54	3d Philadelphia	Dec. 27-31, 1904	890	4175
55	New Orleans	Dec. 29, 1905, to Jan. 4, 1906		

* Including 303 Members of the British Association and 9 other foreign guests.

† Including 24 Foreign Honorary Members for the meeting.

‡ Including 15 Foreign Honorary Members and Associates for the meeting.

Officers of the Meetings of the Association.

[The number before the name is that of the meeting; the year of the meeting follows the name; the asterisk after a name indicates that the member is deceased.]

PRESIDENTS.

1. { Wm. B. Rogers,* 1848. W. C. Redfield,* 1848.
2. Joseph Henry.* 1849.
3. 4. 5. { A. D. Bache,* March meeting, 1850, in the absence of Joseph Henry.* August meeting, 1850. May meeting, 1851.
6. Louis Agassiz,* August meeting, 1851.
(No meeting in 1852.)
7. Benjamin Pierce,* 1853.
8. James D. Dana,* 1854.
9. John Torrey,* 1855.
10. James Hall,* 1856.
11. 12. { Alexis Caswell,* 1857, in place of J. W. Bailey,* deceased. 1858, in the absence of Jeffries Wyman.*
13. Stephen Alexander,* 1859.
14. Isaac Lea,* 1860.
(No meetings for 1861–65.)
15. F. A. P. Barnard,* 1866.
16. J. S. Newberry,* 1867.
17. B. A. Gould,* 1868.
18. J. W. Foster,* 1869.
19. T. Sterry Hunt,* 1870, in the absence of Wm. Chauvenet.*
20. Asa Gray,* 1871.
21. J. Lawrence Smith,* 1872.
22. Joseph Lovering,* 1873.
23. J. L. LeConte,* 1874.
24. J. E. Hilgard,* 1875.
25. William B. Rogers,* 1876.
26. Simon Newcomb, 1877.
27. O. C. Marsh,* 1878.
28. G. F. Barker, 1879.
29. Lewis H. Morgan,* 1880.
30. G. J. Brush, 1881.
31. J. W. Dawson, 1882.
32. C. A. Young, 1883.
33. J. P. Lesley,* 1884.
34. H. A. Newton,* 1885.
35. Edward S. Morse, 1886.
36. S. P. Langley, 1887.
37. J. W. Powell,* 1888.
38. T. C. Mendenhall, 1889.
39. G. Lincoln Goodale, 1890.
40. Albert B. Prescott, 1891.
41. Joseph LeConte,* 1892.
42. William Harkness,* 1893.
43. Daniel G. Brinton,* 1894.
44. E. W. Morley, 1895.
45. { Edward D. Cope,* 1896. Theodore Gill, as senior vice-president acted after the death of Prof. Cope.
46. { Wolcott Gibbs, 1897, absent. W J McGee, Acting President.
47. F. W. Putnam, 1898.
48. { Edward Orton,* 1899. Grove K. Gilbert, elected by the General Committee December, 1899, to fill the vacancy caused by the death of Prof. Orton.
49. R. S. Woodward, 1900.
50. C. S. Minot, 1901.
51. Asaph Hall, 1902.
52. Ira Remsen, 1903.
53. Carroll D. Wright, 1904.
54. W. G. Farlow, 1905.
55. C. M. Woodward, 1906.

VICE-PRESIDENTS.

There were no Vice-Presidents until the 11th meeting when there was a single Vice-President for each meeting. At the 24th meeting, the Association met in Sections A and B, each presided over by a Vice-President. At the 31st meeting nine sections were organized, each with a Vice-President as its presiding officer. In 1886 Section G (Microscopy) was given up. In 1892, Section F was divided into F, Zoology; G, Botany.

1857–1874.

11. ALEXIS CASWELL,* 1857, acted as President.
12. JOHN E. HOLBROOK,* 1858, not present.
13. EDWARD HITCHCOCK,* 1859.
14. B. A. GOULD,* 1860.
15. B. A. GOULD,* 1866, in the absence of R. W. GIBBES.
16. WOLCOTT GIBBS, 1867.
17. CHAS. WHITTLESEY,* 1868.
18. OGDEN N. ROOD, 1869.
19. T. STERRY HUNT,* 1870, acted as President.
20. G. F. BARKER, 1871.
21. ALEX. WINCHELL,* 1872.
22. A. H. WORTHEN,* 1873, not present.
23. C. S. LYMAN,* 1874.

1875–1881.

Section A.—Mathematics, Physics, and Chemistry.

24. H. A. NEWTON,* 1875.
25. C. A. YOUNG, 1876.
26. R. H. THURSTON, 1877, in the absence of E. C. PICKERING.
27. R. H. THURSTON,* 1878.
28. S. P. LANGLEY, 1879.
29. ASAPH HALL, 1880.
30. WM. HARKNESS,* 1881, in the absence of A. M. MAYER.*

Section B.—Natural History.

24. J. W. DAWSON, 1875.
25. EDWARD S. MORSE, 1876.
26. O. C. MARSH,* 1877.
27. AUG. R. GROTE, 1878.
28. J. W. POWELL,* 1879.
29. ALEX. AGASSIZ, 1880.
30. EDWARD T. COX, 1881, in the absence of GEORGE ENGELMANN.*

CHAIRMEN OF SUBSECTIONS, 1875–1881.

Subsection of Chemistry.

24. S. W. JOHNSON, 1875.
25. G. F. BARKER, 1876.
26. N. T. LUPTON,* 1877.
27. F. W. CLARKE, 1878.
28. F. W. CLARKE, 1879, in the absence of IRA REMSEN.
29. J. M. ORDWAY, 1880.
30. G. C. CALDWELL, 1881, in the absence of W. R. NICHOLS.*

Subsection of Microscopy.

25. R. H. WARD, 1876.
26. R. H. WARD, 1877.
27. R. H. WARD, 1878, in the absence of G. S. BLACKIE.*
28. E. W. MORLEY, 1879.
29. S. A. LATTIMORE, 1880.
30. A. B. HERVEY, 1881.

Subsection of Anthropology.

24. LEWIS H. MORGAN,* 1875.
25. LEWIS H. MORGAN,* 1876.
26. DANIEL WILSON,* 1877, not present.
27. United with Section B.
28. DANIEL WILSON,* 1879.
29. J. W. POWELL,* 1880.
30. GARRICK MALLERY,* 1881.

Subsection of Entomology.

30. J. G. MORRIS,* 1881.

VICE-PRESIDENTS OF SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. W. A. ROGERS,* 1882, in the absence of WM. HARKNESS.*
32. W. A. ROGERS,* 1883.
33. H. T. EDDY, 1884.
34. WM. HARKNESS,* 1885, in the absence of J. M. VAN VLECK.
35. J. W. GIBBS,* 1886.
36. J. R. EASTMAN, 1887, in place of W. FERREL,* res'd.
37. ORMOND STONE, 1888.
38. R. S. WOODWARD, 1889.
39. S. C. CHANDLER, 1890.
40. E. W. HYDE, 1891.
41. J. R. EASTMAN, 1892.
42. C. L. DOOLITTLE, 1893.
43. { G. C. COMSTOCK, 1894. / EDGAR FRISBY, 1894. }
44. EDGAR FRISBY, 1895, in place of E. H. HOLDEN, resigned.
45. ALEX. MACFARLANE, 1896, in place of WM. E. STORY, resigned.
46. W. W. BEMAN, 1897.
47. E. E. BARNARD, 1898.
48. ALEX. MACFARLANE, 1899.
49. ASAPH HALL, JR., 1900.
50. JAMES MACMAHON, 1901.
51. G. W. HOUGH, 1902.
52. GEORGE BRUCE HALSTED, 1903.
53. O. H. TITTMANN, 1904.
54. ALEXANDER ZIWET, 1905.
55. W. S. EICHELBERGER, 1906.

Section B.—Physics.

31. T. C. MENDENHALL, 1882.
32. H. A. ROWLAND,* 1883.
33. J. TROWBRIDGE, 1884.
34. S. P. LANGLEY, 1885, in place of C. F. BRACKETT, res'd.
35. C. F. BRACKETT, 1886.
36. W. A. ANTHONY, 1887
37. A. A. MICHELSON, 1888.
38. H. S. CARHART, 1889.
39. CLEVELAND ABBE, 1890.
40. F. E. NIPHER, 1891.
41. B. F. THOMAS, 1892.
42. E. L. NICHOLS, 1893.
43. WM. A. ROGERS, 1894.
44. W. LECONTE STEVENS, 1895.
45. CARL LEO MEES, 1896.
46. CARL BARUS, 1897.
47. F. P. WHITMAN, 1898.
48. ELIHU THOMSON, 1899.
49. ERNEST MERRITT, 1900.
50. D. B. BRACE, 1901.
51. W. S. FRANKLIN, 1902.
52. ERNEST F. NICHOLS, 1903.
53. E. H. HALL, 1904.
54. WM. F. MAGIE, 1905.
55. HENRY CREW, 1906.

Section C.—Chemistry.

31. H. C. BOLTON,* 1882.
32. E. W. MORLEY, 1883.
33. J. W. LANGLEY, 1884.
34. N. T. LUPTON,* 1885, in the absence of W. R. NICHOLS.
35. H. W. WILEY, 1886.
36. A. B. PRESCOTT, 1887.
37. C. E. MUNROE, 1888.
38. W. L. DUDLEY, 1889.
39. R. B. WARDER, 1890.
40. R. C. KEDZIE, 1891.
41. ALFRED SPRINGER, 1892.
42. EDWARD HART, 1893.
43. T. H. NORTON, 1894.
44. WM. MCMURTRIE, 1895.
45. W. A. NOYES, 1896.
46. W. P. MASON, 1897.
47. EDGAR F. SMITH, 1898.
48. F. P. VENABLE, 1899.
49. JAS. LEWIS HOWE, 1900.
50. JOHN H. LONG, 1901.
51. H. A. WEBER, 1902.
52. CHARLES BASKERVILLE, 1903.

VICE-PRESIDENTS OF SECTIONS, CONTINUED.

53. W. D. BANCROFT, 1904.
54. L. P. KINNICUTT, 1905.
55. C. F. MABERY, 1906.

Section D.—Mechanical Science and Engineering.

31. W. P. TROWBRIDGE,* 1882.
32. DEVOLSON WOOD, 1883, absent, but place was not filled.
33. R. H. THURSTON,* 1884.
34. J. BURKITT WEBB, 1885.
35. O. CHANUTE, 1886.
36. E. B. COXE, 1887.
37. C. J. H. WOODBURY, 1888.
38. JAMES E. DENTON, 1889.
39. JAMES E. DENTON, 1890, in place of A. BEARDSLEY, absent.
40. THOMAS GRAY, 1891.
41. J. B. JOHNSON, 1892.
42. S. W. ROBINSON, 1893.
43. MANSFIELD MERRIMAN, 1894.
44. WILLIAM KENT, 1895.
45. FRANK O. MARVIN, 1896.
46. JOHN GALBRAITH, 1897.
47. JOHN GALBRAITH, 1898, in the absence of M.E.COOLEY.
48. STORM BULL, 1899.
49. JOHN A. BRASHEAR, 1900.
50. H. S. JACOBY, 1901.
51. J. J. FLATHER, 1902.
52. CLARENCE A. WALDO, 1903.
53. C. M. WOODWARD, 1904.
54. D. S. JACOBUS, 1905.
55. F. W. MCNAIR, 1906.

Section E.—Geology and Geography.

31. E. T. COX, 1882.
32. C. H. HITCHCOCK, 1883.
33. N. H. WINCHELL, 1884.
34. EDWARD ORTON,* 1885.
35. T. C. CHAMBERLIN, 1886.
36. G. K. GILBERT, 1887.
37. GEORGE H. COOK,* 1888.
38. CHARLES A. WHITE, 1889.
39. JOHN C. BRANNER, 1890.
40. J. J. STEVENSON, 1891.
41. H. S. WILLIAMS, 1892.
42. CHARLES D. WALCOTT, 1893.
43. SAMUEL CALVIN, 1894.
44. JED. HOTCHKISS, 1895.
45. B. K. EMERSON, 1896.
46. { I. C. WHITE, 1897.
  E. W. CLAYPOLE,* 1897.
47. H. L. FAIRCHILD, 1898.
48. J. F. WHITEAVES, 1899.
49. J. F. KEMP, 1900.
50. C. R. VAN HISE, 1901.
51. JOSEPH A. HOLMES, 1902, in the absence of O. A. DERBY.
52. WM. M. DAVIS, 1903.
53. I. C. RUSSELL, 1904.
54. EUGENE A. SMITH, 1905.
55. WM. NORTH RICE, 1906.

Section F.—Biology, 1882–1892.

31. W. H. DALL, 1882.
32. W. J. BEAL, 1883.
33. E. D. COPE,* 1884.
34. T. J. BURRILL, 1885, in the absence of B. G. WILDER.
35. H. P. BOWDITCH, 1886.
36. W. G. FARLOW, 1887.
37. C. V. RILEY,* 1888.
38. GEORGE L. GOODALE, 1889.
39. C. S. MINOT, 1890.
40. J. M. COULTER, 1891.
41. S. H. GAGE, 1892.

Section F.—Zoology.

42. HENRY F. OSBORN, 1893.
43. J. A. LINTNER,* 1894, in place of S. H. SCUDDER, res'd.
44. L. O. HOWARD, 1895, in place of D. S. JORDAN, res'd.
45. THEO. GILL, 1896.
46. L. O. HOWARD, 1897, in place of G. BROWN GOODE,* deceased.
47. A. S. PACKARD, 1898.

VICE-PRESIDENTS OF SECTIONS, CONTINUED.

48. S. H. GAGE, 1899.
49. C. B. DAVENPORT, 1900.
50. D. S. JORDAN, 1901.
51. E. L. MARK, 1902, in the absence of C. C. NUTTING.
52. C. W. HARGITT, 1903.
53. E. L. MARK, 1904.
54. C. HART MERRIAM, 1905.
55. H. B. WARD, 1906.

Section G. Microscopy, 1882–85.

31. A. H. TUTTLE, 1882.
32. J. D. COX, 1883.
33. T. G. WORMLEY,* 1884.
34. S. H. GAGE, 1885.

(Section united with F in 1886)

Section G.—Botany.

42. CHARLES E. BESSEY, 1893.
43. { L. M. UNDERWOOD, 1894.
C. E. BESSEY, 1894. }
44. J. C. ARTHUR, 1895.
45. N. L. BRITTON, 1896.
46. G. F. ATKINSON, 1897.
47. W. G. FARLOW, 1898.
48. C. R. BARNES, 1899.
49. W. TRELEASE, 1900.
50. B. T. GALLOWAY, 1901.
51. C. E. BESSEY, 1902, in the absence of D. H. CAMPBELL.
52. F. V. COVILLE, 1903.
53. T. H. MACBRIDE, 1904.
54. B. L. ROBINSON, 1905.
55. ERWIN F. SMITH, 1906.

Section H.—Anthropology.

31. ALEX. WINCHELL,* 1882.
32. OTIS T. MASON, 1883.
33. EDWARD S. MORSE, 1884.
34. J. OWEN DORSEY,* 1885, in the absence of W. H. DALL.
35. HORATIO HALE,* 1886.
36. D. G. BRINTON,* 1887.
37. CHARLES C. ABBOTT, 1888.
38. GARRICK MALLERY,* 1889.
39. FRANK BAKER, 1890.
40. JOSEPH JASTROW, 1891.
41. W. H. HOLMES, 1892.
42. J. OWEN DORSEY,* 1893.
43. FRANZ BOAS, 1894.
44. F. H. CUSHING,* 1895.
45. ALICE C. FLETCHER, 1896.
46. W J MCGEE, 1897.
47. J. MCK. CATTELL, 1898.
48. THOMAS WILSON,* 1899.
49. A. W. BUTLER, 1900.
50. J. WALTER FEWKES, 1901.
51. STEWART CULIN, 1902.
52. GEO. A. DORSEY, 1903.
53. M. H. SAVILLE, 1904.
54. WALTER HOUGH, 1905.
55. GEORGE GRANT MCCURDY, 1906.

Section I.—Social and Economic Science.

31. E. B. ELLIOTT,* 1882.
32. FRANKLIN B. HOUGH,* 1883.
33. JOHN EATON,* 1884.
34. EDWARD ATKINSON, 1885.
35. JOSEPH CUMMINGS,* 1886.
36. H. E. ALVORD, 1887.
37. CHARLES W. SMILEY, 1888.
38. CHARLES S. HILL, 1889.
39. J. RICHARDS DODGE, 1890.
40. EDMUND J. JAMES, 1891.
41. L. F. WARD, 1892, in place of S. D. HORTON,* resigned.
42. WILLIAM H. BREWER, 1893.
43. HENRY FARQUHAR, 1894.
44. B. E. FERNOW, 1895.
45. W. L. LAZENBY, 1896.
46. R. T. COLBURN, 1897.
47. ARCHIBALD BLUE, 1898.
48. MARCUS BENJAMIN, 1899.
49. MARCUS BENJAMIN, 1900, in the absence of C. M. WOODWARD.
50. JOHN HYDE, 1901.
51. JOHN HYDE, 1902, in the absence of CARROLL D. WRIGHT.

SECRETARIES OF THE SECTIONS, CONTINUED.

52. H. T. NEWCOMB, 1903.
53. SIMEON E. BALDWIN, 1904.
54. MARTIN A. KNAPP, 1905.
55. IRVING FISHER, 1906.

Section K.—Physiology and Experimental Medicine.

51. W. H. WELCH, 1902.
52. W. H. WELCH, 1903.
53. H. P. BOWDITCH, 1904.
54. H. P. BOWDITCH, 1905.
55. W. T. SEDGWICK, 1906.

SECRETARIES.

General Secretaries, 1848–

1. WALTER R. JOHNSON,* 1848
2. E. N. HORSFORD,* 1849, in the absence of JEFFRIES WYMAN.*
3. L. R. GIBBS, 1850, in the absence of E. C. HERRICK.*
4. E. C. HERRICK,* 1850.
5. WM. B. ROGERS,* 1851, in the absence of E. C. HERRICK.*
6. WM. B. ROGERS,* 1851.
7. S. ST. JOHN,* 1853, in the absence of J. D. DANA.*
8. J. LAWRENCE SMITH,* 1854.
9. WOLCOTT GIBBS, 1855.
10. B. A. GOULD,* 1856.
11. JOHN L. LECONTE,* 1857.
12. W. M. GILLESPIE,* 1858, in the absence of WM. CHAUVENET.*
13. WM. CHAUVENET,* 1859.
14. JOSEPH LECONTE,* 1860.
15. ELIAS LOOMIS,* 1866, in the absence of W. P. TROWBRIDGE.*
16. C. S. LYMAN,* 1867.
17. SIMON NEWCOMB, 1868, in the absence of A. P. ROCKWELL.
18. O. C. MARSH,* 1869.
19. F. W. PUTNAM, 1870, in the absence of C. F. HARTT.*
20. F. W. PUTNAM, 1871.
21. EDWARD S. MORSE, 1872.
22. C. A. WHITE, 1873.
23. A. C. HAMLIN, 1874.
24. S. H. SCUDDER, 1875.
25. T. C. MENDENHALL, 1876.
26. AUG. R. GROTE, 1877.
27. H. C. BOLTON,* 1878.
28. H. C. BOLTON,* 1879, in the absence of GEORGE LITTLE.
29. J. K. REES, 1880.
30. C. V. RILEY,* 1881.
31. WILLIAM SAUNDERS, 1882.
32. J. R. EASTMAN, 1883.
33. ALFRED SPRINGER, 1884.
34. C. S. MINOT, 1885.
35. S. G. WILLIAMS,* 1886.
36. WILLIAM H. PETTEE, 1887.
37. JULIUS POHLMAN, 1888.
38. C. LEO MEES, 1889.
39. H. C. BOLTON,* 1890.
40. H. W. WILEY, 1891.
41. A. W. BUTLER, 1892.
42. T. H. NORTON, 1893.
43. H. L. FAIRCHILD, 1894.
44. JAS. LEWIS HOWE, 1895.
45. CHARLES R. BARNES, 1896.
46. ASAPH HALL, JR., 1897.
47. J. MCMAHON, 1898, in place of D. S. KELLICOTT,* deceased.
48. F. BEDELL, 1899.
49. CHAS. BASKERVILLE, 1900.
50. JOHN M. COULTER, 1901, in the absence of WILLIAM HALLOCK.
51. D. T. MACDOUGAL, 1902.
52. HENRY B. WARD, 1903.
53. C. W. STILES, 1904.
54. CHARLES S. HOWE, 1905.
55. C. A. WALDO, 1906.

Permanent Secretaries, 1851–

5–7. SPENCER F. BAIRD,* 1851–4
8–17. JOSEPH LOVERING,* 1854–68.
18. F. W. PUTNAM, 1869, in the absence of J. LOVERING.*

Secretaries, Continued.

19–21. Joseph Lovering,* 1870–73.
22–46. F. W. Putnam, 1873–98.
47–54. L. O. Howard, 1898–05.
55–59. L. O. Howard, 1906–10.

Assistant General Secretaries, 1882–1887.

31. J. R. Eastman, 1882.
32. Alfred Springer, 1883.
33. C. S. Minot, 1884, in the absence of E. S. Holden.
34. S. G. Williams,* 1885, in the absence of C. C. Abbott.
35. W. H. Pettee, 1886.
36. J. C. Arthur, 1887.

Secretaries of the Council, 1888–

37. C. Leo Mees, 1888.
38. H. C. Bolton,* 1889.
39. H. W. Wiley, 1890.
40. A. W. Butler, 1891.
41. T. H. Norton, 1892.
42. H. Leroy Fairchild, 1893.
43. Jas. Lewis Howe, 1894.
44. Charles R. Barnes, 1895.
45. Asaph Hall, Jr., 1896.
46. D. S. Kellicott,* 1897.
47. Frederick Bedell, 1898.
48. Charles Baskerville, 1899.
49. William Hallock, 1900.
50. D. T. MacDougal, 1901.
51. H. B. Ward, 1902.
52. Ch. Wardell Stiles, 1903.
53. Chas. S. Howe, 1904.
54. C. A. Waldo, 1905.
55. John T. Hayford, 1906.

Secretaries of Section A.—Mathematics, Physics and Chemistry, 1875–1881.

24. { S. P. Langley, 1875. / T. C. Mendenhall, 1875. }
25. A. W. Wright, 1876.
26. H. C. Bolton,* 1877.
27. F. E. Nipher, 1878.
28. J. K. Rees, 1879.
29. H. B. Mason, 1880.
30. E. T. Tappan, 1881, in the absence of Jno. Trowbridge.

Secretaries of Section B.—Natural History, 1874–1881.

24. Edward S. Morse, 1875.
25. Albert H. Tuttle, 1876.
26. William H. Dall, 1877.
27. George Little, 1878.
28. Wm. H. Dall, 1879, in the absence of A. C. Wetherby.
29. Charles V. Riley,* 1880.
30. William Saunders, 1881.

Secretaries of Subsections, 1875–1881.

Subsection of Chemistry.

24. F. W. Clarke, 1875.
25. H. C. Bolton,* 1876.
26. P. Schweitzer, 1877.
27. A. P. S. Stuart, 1878.
28. W. R. Nichols,* 1879.
29. C. E. Munroe, 1880.
30. Alfred Springer, 1881, in the absence of R. B. Warder.

Subsection of Entomology.

30. B. P. Mann, 1881.

Subsection of Anthropology.

24. F. W. Putnam, 1875.
25. Otis T. Mason, 1876.
26, 27. United with Section B.
28, 29, 30. J. G. Henderson. 1879–81.

Subsection of Microscopy.

25. E. W. Morley, 1876.
26. T. O. Sommers, Jr., 1877.
27. G. J. Engelmann, 1878.
28, 29. A. B. Hervey, 1879–80.
30. W. H. Seaman, 1881, in the absence of S. P. Sharples.

SECRETARIES OF THE SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. H. T. EDDY, 1882.
32. G. W. HOUGH, 1883, in the absence of W. W. JOHNSON.
33. G. W. HOUGH, 1884.
34. E. W. HYDE, 1885.
35. S. C. CHANDLER, 1886.
36. H. M. PAUL, 1887.
37. C. C. DOOLITTLE, 1888.
38. G. C. COMSTOCK, 1889.
39. W. W. BEMAN, 1890.
40. F. H. BIGELOW, 1891.
41. WINSLOW UPTON, 1892.
42. C. A. WALDO, 1893, in the absence of A. W. PHILLIPS.
43. J. C. KERSHNER, 1894, in place of W. W. BEMAN, res'd.
44. ASAPH HALL, JR., 1895, in place of E. H. MOORE, res'd.
45. EDWIN B. FROST, 1896.
46. JAMES MCMAHON, 1897.
47. WINSLOW UPTON, 1898, in place of ALEX. ZIWET, resigned.
48. JOHN F. HAYFORD, 1899.
49. W. M. STRONG, 1900.
50. G. A. MILLER, 1901, in place of H. C. LORD, resigned.
51. E. S. CRAWLEY, 1902.
52. C. S. HOWE, 1903.

53–57. L. G. WELD, 1904–1908.

Section B.—Physics.

31. C. S. HASTINGS, 1882.
32. F. E. NIPHER, 1883, in the absence of C. K. WEAD.
33. N. D. C. HODGES, 1884.
34. B. F. THOMAS, 1885, in place of A. A. MICHELSON, resigned.
35. H. S. CARHART, 1886.
36. C. LEO MEES, 1887.
37. ALEX. MACFARLANE, 1888.
38. E. L. NICHOLS, 1889.
39. E. M. AVERY, 1890.
40. ALEX. MACFARLANE, 1891.
41. BROWN AYRES, 1892.
42. W. LECONTE STEVENS, 1893.
43. B. W. SNOW, 1894.
44. E. MERRITT, 1895.
45. FRANK P. WHITMAN, 1896.
46. FREDERICK BEDELL, 1897.
47. W. S. FRANKLIN, 1898, in place of E. B. ROSA, resigned.
48. WILLIAM HALLOCK, 1899.
49. R. A. FESSENDEN, 1900.
50. JOHN ZELENY, 1901, in place of J. O. REED, resigned.
51. E. F. NICHOLS, 1902.
52. D. C. MILLER, 1903.

53–57. D. C. MILLER, 1904–1908.

Section C.—Chemistry.

31. ALFRED SPRINGER, 1882.
32. J. W. LANGLEY, 1883. / W. MCMURTRIE, 1883.
33. H. CARMICHAEL, 1884, in the absence of R. B. WARDER.
34. F. P. DUNNINGTON, 1885.
35. W. MCMURTRIE, 1886.
36. C. F. MABERY, 1887.
37. W. L. DUDLEY, 1888.
38. EDWARD HART, 1889.
39. W. A. NOYES, 1890.
40. T. H. NORTON, 1891.
41. JAS. LEWIS HOWE, 1892.
42. H. N. STOKES, 1893, in the absence of J. U. NEF.
43. MORRIS LOEB, 1894, in place of S. M. BABCOCK, resigned.
44. W. P. MASON, 1895. / W. O. ATWATER, 1895.
45. FRANK P. VENABLE, 1896.
46. P. C. FREER, 1897.
47. C. BASKERVILLE, 1898.
48. H. A. WEBER, 1899.
49. A. A. NOYES, 1900.
50. W. MCPHERSON, 1901.

SECRETARIES OF THE SECTIONS, CONTINUED.

51. F. C. PHILLIPS, 1902.
52. H. N. STOKES, 1903.
53–57. CHAS. L. PARSONS, 1904–1908.

Section D.—Mechanical Science and Engineering.

31. J. BURKITT WEBB, 1882, in the absence of C. B. DUDLEY.
32. J. BURKITT WEBB, 1883, *pro tempore.*
33. J. BURKITT WEBB, 1884.
34. C. J. H. WOODBURY, 1885.
35. WILLIAM KENT, 1886.
36. G. M. BOND, 1887.
37. ARTHUR BEARDSLEY, 1888.
38. W. B. WARNER, 1889.
39. THOMAS GRAY, 1890.
40. WILLIAM KENT, 1891.
41. O. H. LANDRETH, 1892.
42. D. S. JACOBUS, 1893.
43. JOHN H. KINEALY, 1894.
44. H. S. JACOBY, 1895.
45. JOHN GALBRAITH, 1896.
46. JOHN J. FLATHER, 1897.
47. JOHN J. FLATHER, 1898, in the absence of W. S. ALDRICH.
48. J. M. PORTER, 1899.
49. W. T. MAGRUDER, 1900.
50. C. W. COMSTOCK, 1901, in the absence of W. H. JAQUES.
51. C. A. WALDO, 1902.
52. ELWOOD MEAD, 1903, in the absence of ALBERT KINGSBURY.
53–57. W. T. MAGRUDER, 1904–1908.

Section E.—Geology and Geography.

31. H. S. WILLIAMS, 1882, in the absence of C. E. DUTTON.
32. A. A. JULIEN, 1883.
33. E. A. SMITH, 1884.
34. G. K. GILBERT, 1885, in the absence of H. C. LEWIS.*
35. E. W. CLAYPOLE,* 1886.
36. W. M. DAVIS, 1887, in the absence of T. B. COMSTOCK.
37. JOHN C. BRANNER, 1888.
38. JOHN C. BRANNER, 1889.
39. SAMUEL CALVIN, 1890.
40. W J McGEE, 1891.
41. R. D. SALISBURY, 1892.
42. W. H. HOBBS,* 1893, in place of R. T. HILL, resigned.
43. JED. HOTCHKISS,* 1894, in place of W. M. DAVIS, res'd.
44. J. PERRIN SMITH, 1895.
45. W. N. RICE, 1896, in place of A. C. GILL, resigned.
46. C. H. SMITH, JR., 1897.
47. WARREN UPHAM, 1898.
48. ARTHUR HOLLICK, 1899.
49. J. A. HOLMES, 1900.
50. H. B. PATTON, 1901, in the absence of R. A. F. PENROSE.
51. F. P. GULLIVER, 1902.
52. E. O. HOVEY, 1903.
53. G. B. SHATTUCK, 1904.
54–57. EDMUND O. HOVEY, 1905–1908.

Section F.—Biology, 1882–1892.

31. WILLIAM OSLER, 1882, in the absence of C. S. MINOT.
32. S. A. FORBES, 1883.
33. C. E. BESSEY, 1884.
34. J. A. LINTNER,* 1885, in place of C. H. FERNALD, res'd
35. J. C. ARTHUR, 1886.
36. J. H. COMSTOCK, 1887.
37. B. E. FERNOW, 1888.
38. A. W. BUTLER, 1889.
39. J. M. COULTER, 1890.
40. A. J. COOK, 1891.
41. D. B. HALSTEAD, 1892.

Section F.—Zoology.

42. L. O. HOWARD, 1893.
43. JOHN B. SMITH, 1894, in place of WM. LIBBY, JR., resigned.

SECRETARIES OF THE SECTIONS, CONTINUED.

44. C. W. HARGITT, 1895, in place of S. A. FORBES, res'd
45. D. S. KELLICOTT,* 1896.
46. C. C. NUTTING, 1897.
47. R. T. JACKSON, 1898, in place of C. W. STILES, resigned.
48. C. L. MARLATT, 1899, in place of F. W. TRUE, resigned.
49. C. H. EIGENMANN, 1900.
50. H. B. WARD, 1901.
51. C. W. STILES, 1902.
52. C. J. HERRICK, 1903.
53–57. C. J. HERRICK, 1904–08.

Section G.—Microscopy, 1882–85.

31. ROBERT BROWN, JR., 1882.
32. CARL SEILER, 1883.
33. ROMYN HITCHCOCK, 1884.
34. W. H. WALMSLEY, 1885.

Section G.—Botany.

42. B. T. GALLOWAY, 1893, in the absence of F. V. COVILLE.
43. CHAS. R. BARNES, 1894.
44. B. T. GALLOWAY, 1895. M. B. WAITE, 1895.
45. GEORGE F. ATKINSON, 1896.
46. F. C. NEWCOMBE, 1897.
47. ERWIN F. SMITH, 1898.
48. W. A. KELLERMAN, 1899.
49. D. T. MACDOUGAL, 1900.
50. ERNST A. BESSEY, 1901, in the absence of A. S. HITCHCOCK.
51. H. VON SCHRENK, 1902.
52. C. J. CHAMBERLAIN, 1903.
53–57. F. E. LLOYD, 1904–1908.

Section H.—Anthropology.

31. OTIS T. MASON, 1882.
32. G. H. PERKINS, 1883.
33. G. H. PERKINS, 1884, in the absence of W. H. HOLMES.
34. ERMINNIE A. SMITH,* 1885.
35. A. W. BUTLER, 1886.
36. CHAS. C. ABBOTT, 1887, in the absence of F. W. LANGDON.
37. FRANK BAKER, 1888.
38. W. M. BEAUCHAMP, 1889.
39. JOSEPH JASTROW, 1890.
40. W. H. HOLMES, 1891.
41. W. M. BEAUCHAMP, 1892, in place of S. CULIN, resigned.
42. W. K. MOOREHEAD, 1893.
43. A. F. CHAMBERLIN, 1894.
44. STEWART CULIN and W. W. TOOKER, 1895, in place of ANITA N. MCGEE, res'd.
45. G. H. PERKINS, 1896, in place of J. G. BOURKE,* dec'd..
46. ANITA N. MCGEE, 1897, in place of HARLAN I. SMITH, res'd.
47. MARSHALL H. SAVILLE, 1898.
48. E. W. SCRIPTURE, 1899, in place of GEO. A. DORSEY, resigned.
49. FRANK RUSSELL,* 1900.
50. G. G. MACCURDY, 1901.
51. HARLAN I. SMITH, 1902.
52. R. B. DIXON, 1903.
53–57. GEO. H. PEPPER, 04–08.

Section I.—Social and Economic Science.

31. FRANKLIN B. HOUGH,* 1882. J. RICHARDS DODGE, 1882.
32. JOSEPH CUMMINGS,* 1883.
33. CHARLES W. SMILEY, 1884.
34. CHAS. W. SMILEY, 1885, in the absence of J. W. CHICKERING.
35. H. E. ALVORD, 1886.
36. W. R. LAZENBY, 1887.
37. CHARLES S. HILL, 1888.
38. J. RICHARDS DODGE, 1889.
39. B. E. FERNOW, 1890.
40. B. E. FERNOW, 1891.
41. HENRY FARQUHAR, 1892, in place of L. F. WARD, made Vice-President.

SECRETARIES OF THE SECTIONS, CONTINUED.

42. NELLIE S. KEDZIE, 1893.
43. MANLEY MILES, 1894.
44. W. R. LAZENBY, 1895, in place of E. A. Ross, resigned.
45. R. T. COLBURN, 1896.
46. ARCHIBALD BLUE, 1897.
47. MARCUS BENJAMIN, 1898.
48. CALVIN M. WOODWARD, 1899.
49. H. T. NEWCOMB, 1900.
50. R. A. PEARSON, 1901, in place of CORA A. BENNESON, res'd.
51. F. R. RUTTER, 1902, in place of Walter F. Willcox, resigned.
52. F. H. HITCHCOCK, 1903.
53–57. J. F. CROWELL, 1904–08.

Section K.—Physiology and Experimental Medicine.

51. F. S. LEE, 1902.
52. F. S. LEE, 1903.
53. F. S. LEE, 1904.
54–57. W. J. GIES, 1905–08.

TREASURERS.

1. JEFFRIES WYMAN,* 1848.
2. A. L. ELWYN,* 1849.
3. ST. J. RAVENEL,* 1850, in the absence of A. L. ELWYN.*
4. A. L. ELWYN,* 1850.
5. SPENCER F. BAIRD,* 1851, in the absence of A. L. ELWYN.*
6–7. A. L. ELWYN,* 1851–53.
8. J. L. LECONTE,* 1854, in the absence of A. L. ELWYN.*
9–19. A. L. ELWYN,* 1855–1870.
20–30. WM. S. VAUX,* 1871–1881.
32–42. WM. LILLY,* 1882–93.
43–49. R. S. WOODWARD, 1894–1900.
50–54. R. S. WOODWARD, 1901–1905.
55–59. R. S. WOODWARD, 1906–1910.

Commonwealth of Massachusetts.

In the Year One Thousand Eight Hundred and Seventy-Four.

AN ACT

TO INCORPORATE THE "AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE."

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows:

SECTION 1. Joseph Henry of Washington, Benjamin Pierce of Cambridge, James D. Dana of New Haven, James Hall of Albany, Alexis Caswell of Providence, Stephen Alexander of Princeton, Isaac Lea of Philadelphia, F. A. P. Barnard of New York, John S. Newberry of Cleveland, B. A. Gould of Cambridge, T. Sterry Hunt of Boston, Asa Gray of Cambridge, J. Lawrence Smith of Louisville, Joseph Lovering of Cambridge, and John LeConte of Philadelphia, their associates, the officers and members of the Association, known as the "American Association for the Advancement of Science," and their successors, are hereby made a corporation by the name of the "American Association for the Advancement of Science," for the purpose of receiving, purchasing, holding, and conveying real and personal property, which it now is, or hereafter may be, possessed of, with all the powers and privileges, and subject to the restrictions, duties and liabilities set forth in the general laws which now or hereafter may be in force and applicable to such corporations.

SECTION 2. Said corporation may have and hold by purchase, grant, gift, or otherwise, real estate not exceeding one hundred thousand dollars in value, and personal estate of the value of two hundred and fifty thousand dollars.

SECTION 3. Any two of the corporators above named are hereby authorized to call the first meeting of the said corporation in the month of August next ensuing, by notice thereof "by mail," to each member of the said Association.

SECTION 4. This act shall take effect upon its passage.

HOUSE OF REPRESENTATIVES, March 10, 1874.
Passed to be enacted,
JOHN E. SANFORD, *Speaker*.

IN SENATE, March 17, 1874.
Passed to be enacted,
GEO. B. LORING, *President*.

March 19, 1874.
Approved.
W. B. WASHBURN.

SECRETARY'S DEPARTMENT,
Boston, April 3, 1874.
A true copy, Attest:
DAVID PULSIFER,
Deputy Secretary of the Commonwealth.

CONSTITUTION

OF THE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Incorporated by Act of the General Court of the Commonwealth of Massachusetts.

OBJECTS.

ARTICLE 1. The objects of the Association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness.

MEMBERSHIP.

ART. 2. The Association shall consist of members, fellows, patrons, corresponding members and honorary fellows.

MEMBERS.

ART. 3. Any person may become a member of the Association upon recommendation in writing by two members or fellows, and election by the Council. Any incorporated scientific society or institution, or any public or incorporated library, may be enrolled as a member of the Association by vote of the Council by payment of the initiation fee; such society, institution, or library may be represented by either the President, Curator, Director, or Librarian presenting proper credentials at any meeting of the Association for which the assessment has been paid.

ASSOCIATES.

Associates for any single meeting shall be admitted on the payment of three dollars, such associates to have all the privileges of the meeting, except reading papers and voting.

Members of scientific societies whose meetings are contemporaneous with, or immediately subsequent to, that of the Associa-

tion, and which are recognized by vote of the Council as "Affiliated Societies," may become associate members for that meeting on the payment of three dollars. They shall be entitled to all the privileges of membership except voting or appointment to office, but their names shall not appear in the list of members printed in the annual report.

Foreign Associates.

Any member or fellow of any national scientific or educational institution, or of any society or academy of science, of any country not in America, who may be present at any meeting of the Association shall, on presenting the proper credentials, be enrolled without fee as a Foreign Associate, and shall be entitled to all the privileges of the meeting except voting on matters of business.

Fellows.

Art. 4. Fellows shall be elected by the Council from such of the members as are professionally engaged in science, or have, by their labors, aided in advancing science. The election of fellows shall be by ballot, and a majority vote of the members of the Council at a designated meeting of the Council.

Patrons.

Art. 5. Any person paying to the Association the sum of one thousand dollars shall be classed as a patron, and shall be entitled to all the privileges of a member and to all its publications.

Honorary Fellows and Corresponding Members.

Art. 6. Honorary fellows of the Association, not exceeding three for each Section, may be elected, the nominations to be made by the Council and approved by ballot in the respective sections before election by ballot in General Session. Honorary fellows shall be entitled to all the privileges of fellows, and shall be exempt from all fees and assessments, and entitled to all publications of the Association issued after the date of their election. Corresponding members shall consist of such scientists not residing in America as may be elected by the Council, and their number shall be limited to fifty. Corresponding members shall be entitled to

all the privileges of members and to the annual volumes of Proceedings published subsequent to their election.

SUSPENSIONS.

ART. 7. The name of any member or fellow two years in arrears for annual dues shall be erased from the list of the Association, provided, that two notices of indebtedness, at an interval of at least three months, shall have been given; and no such person shall be restored until he has paid his arrearages or has been re-elected. The Council shall have power to exclude from the Association any member or fellow, on satisfactory evidence that said member or fellow is an improper person to be connected with the Association, or has in the estimation of the Council made improper use of his membership or fellowship.

OFFICERS.

ART. 8. No member or fellow shall take part in the organization of, or hold office in, more than one section at any one meeting.

ART. 9. The officers of the Association shall be elected by ballot by the General Committee from the fellows, and shall consist of a President, a Vice-President from each section, a Permanent Secretary, a General Secretary, a Secretary of the Council, a Treasurer, and a Secretary of each Section: these, with the exception of the Permanent Secretary, the Treasurer, and the Secretaries of the Sections, shall be elected at each meeting for the following one, and, with the exception of the Treasurer and the Permanent Secretary, shall not be re-eligible for the next two meetings. The term of office of the Permanent Secretary, of the Treasurer, and of the Secretaries of the Sections, shall be five years.

PRESIDENT.

ART. 10. The President, or, in his absence, the senior Vice-President present, shall preside at all General Sessions of the Association and at all meetings of the Council. It shall also be the duty of the President to give an address at a General Session of the Association at the meeting following that over which he presided.

VICE-PRESIDENTS.

ART. 11. The Vice-Presidents shall be chairmen of their respective Sections, and of their Sectional Committees, and it

shall be part of their duty to give an address, each before his own Section, at such time as the Council shall determine at the meeting subsequent to that at which he presides. The Vice-Presidents may appoint temporary chairmen to preside over the sessions of their sections, but shall not delegate their other duties. The Vice-Presidents shall have seniority in order of their continuous membership in the Association.

General Secretary.

Art. 12. The General Secretary shall be the Secretary of all General Sessions of the Association, and shall keep a record of the business of these sessions. He shall receive the records from the Secretaries of the Sections, which, after examination, he shall transmit with his own records to the Permanent Secretary within two weeks after the adjournment of the meeting.

Secretary of the Council.

Art. 13. The Secretary of the Council shall keep the records of the Council. He shall give to the Secretary of each Section the titles of papers assigned to it by the Council. He shall receive proposals for membership and bring them before the Council.

Permanent Secretary.

Art. 14. The Permanent Secretary shall be the executive officer of the Association under the direction of the Council. He shall attend to all business not specially referred to committees nor otherwise constitutionally provided for. He shall keep an account of all business that he has transacted for the Association, and make annually a general report for publication in the annual volume of Proceedings. He shall attend to the printing and distribution of the annual volume of Proceedings, and all other printing ordered by the Association. He shall issue a circular of information to members and fellows at least three months before each meeting, and shall, in connection with the Local Committee, make all necessary arrangements for the meetings of the Association. He shall provide the Secretaries of the Association with such books and stationery as may be required for their records and business, and shall provide members and fellows with such blank forms as may be required for facilitating the business of the Association. He shall collect all assessments

and admission fees, and notify members and fellows of their election, and of any arrearages. He shall receive, and bring before the Council, the titles and abstracts of papers proposed to be read before the Association. He shall keep an account of all receipts and expenditures of the Association, and report the same annually at the first meeting of the Council, and shall pay over to the Treasurer such unexpended funds as the Council may direct. He shall receive and hold in trust for the Association all books, pamphlets, and manuscripts belonging to the Association, and allow the use of the same under the provisions of the Constitution and the orders of the Council. He shall receive all communications addressed to the Association during the intervals between meetings, and properly attend to the same. He shall at each meeting report the names of fellows and members who have died since the preceding meeting. He shall be allowed a salary which shall be determined by the Council, and may employ one or more clerks at such compensation as may be agreed upon by the Council.

Treasurer.

Art. 15. The Treasurer shall invest the funds received by him in such securities as may be directed by the Council. He shall annually present to the Council an account of the funds in his charge. No expenditure of the principal in the hands of the Treasurer shall be made without a unanimous vote of the Council, and no expenditure of the income received by the Treasurer shall be made without a two-thirds vote of the Council. The Treasurer shall give bonds for the faithful performance of his duty in such manner and sum as the Council shall from time to time direct.

Secretaries of the Sections.

Art. 16. The Secretaries of the Sections shall keep the records of their respective Sections, and, at the close of the meeting, give the same, including the records of subsections, to the General Secretary. They shall also be the Secretaries of the sectional committees. The Secretaries shall have seniority in order of their continuous membership in the Association.

Vacancies.

Art. 17. In case of a vacancy in the office of President, the senior Vice-President shall preside, as provided in Article 10

until the General Committee can be assembled and the vacancy filled by election. Vacancies in the offices of Vice-President, Permanent Secretary, Secretary of the Council, Secretaries of the Sections, and Treasurer, shall be filled by the Council by ballot.

COUNCIL.

ART. 18. The Council shall consist of the Past Presidents, and the Vice-Presidents of the last two meetings, together with the President, the Vice-Presidents, the Permanent Secretary, the General Secretary, the Secretary of the Council, the Secretaries of the Sections, and the Treasurer of the current meeting, of one fellow elected from each Section by ballot on the first day of its meeting, of one fellow elected by each affiliated society, and one additional fellow from each affiliated society having more than twenty-five members who are fellows of the Association, and of nine fellows elected by the Council, three being annually elected for a term of three years. The members present at any regularly called meeting of the Council, provided there are at least five, shall form a quorum for the transaction of business. The Council shall meet on the day preceding each annual meeting of the Association, and arrange the program for the first day of the sessions. The time and place of this first meeting shall be designated by the Permanent Secretary. Unless otherwise agreed upon, regular meetings of the Council shall be held in the Council room at 9 o'clock A. M., on each day of the meeting of the Association. Special meetings of the Council may be called at any time by the President. The Council shall be the board of supervision of the Association, and no business shall be transacted by the Association that has not first been referred to, or originated with, the Council. The Council shall decide which papers, discussions, and other proceedings shall be published, and have the general direction of the publications of the Association; manage the financial affairs of the Association; arrange the business and programs for General Sessions; suggest subjects for discussion, investigation or reports; elect members and fellows; and receive and act upon all invitations extended to the Association and report the same at a General Session of the Association. The Council shall receive all reports of Special Committees and decide upon them, and only such shall be read in General

Session as the Council shall direct. The Council shall appoint at each meeting the following subcommittees who shall act, subject to appeal to the whole Council, until their successors are appointed at the following meeting: 1, on Papers and Reports; 2, on Members; 3, on Fellows.

GENERAL COMMITTEE.

ART. 19. The General Committee shall consist of the Council and one member or fellow elected by each of the Sections, who shall serve until their successors are elected. It shall be the duty of the committee to meet at the call of the President and elect the general officers for the following meeting of the Association. It shall also be the duty of this committee to fix the time and place for the next meeting. The Vice-President and Secretary of each Section shall be recommended to the General Committee by the Sectional Committee.

MEETINGS.

ART. 20. The Association shall hold a public meeting annually, for one week or longer, at such time and place as may be determined by vote of the General Committee, and the preliminary arrangements for each meeting shall be made by the Local Committee, in conjunction with the Permanent Secretary and such other persons as the Council may designate.

But if suitable preliminary arrangements cannot be made, the Council may afterward change the time and place appointed by the General Committee, if such change is believed advisable, by two-thirds of the members present.

ART. 21. A General Session shall be held at 10 o'clock, A. M., on the first day of the meeting, and at such other times as the Council may direct.

SECTIONS AND SUBSECTIONS.

ART. 22. The Association shall be divided into Sections, namely:—A, *Mathematics and Astronomy;* B, *Physics;* C, *Chemistry, including its application to Agriculture and the Arts;* D, *Mechanical; Science and Engineering;* E, *Geology and Geography;* F, *Zoology,* G, *Botany;* H, *Anthropology;* I, *Social and Economic Science;* K *Physiology and Experimental Medicine.* The Council shall have

power to consolidate any two or more Sections temporarily, and such consolidated Sections shall be presided over by the senior Vice-President and Secretary of the Sections comprising it.

SECTIONAL COMMITTEES.

ART. 23. Immediately on the organization of a Section there shall be a member or fellow elected by ballot after open nomination, who, with the Vice-President and Secretary and the Vice-President and Secretary of the preceding meeting, and the members or fellows elected by ballot at the four preceding meetings, shall form its Sectional Committee. The Sectional Committees shall have power to fill vacancies in their own numbers. Meetings of the Sections shall not be held at the same time with a General Session. The Sectional Committee may invite distinguished foreign associates present at any meeting to serve as honorary members of said Committee.

ART. 24. The Sectional Committee of any Section may at its pleasure form one or more temporary Subsections, and may designate the officers thereof. The Secretary of a Subsection shall, at the close of the meeting, transmit his records to the Secretary of the Section.

ART. 25. No paper shall be read in any Section or Subsection until it has been placed on the program of the day by the Sectional Committee.

ART. 26. The Sectional Committees shall arrange and direct the business of their respective Sections. They shall prepare the daily programs and give them to the Permanent Secretary for printing at the earliest moment practicable. No titles of papers shall be entered on the daily programs except such as have passed the Committee. No change shall be made in the program for the day in a Section without the consent of the Sectional Committee. The Sectional Committees may refuse to place the title of any paper on the program; but every such title, with the abstract of the paper or the paper itself, must be referred to the Council with the reasons why it was refused. The Sectional Committee shall also make nominations to the General Committee for Vice-President and Secretary of their respective Sections as provided for in Article 19.

ART. 27. The Sectional Committees shall examine all papers and abstracts referred to the Sections, and they shall not place

on the program any paper inconsistent with the character of the Association; and to this end they have power to call for any paper, the character of which may not be sufficiently understood from the abstract submitted.

PAPERS AND COMMUNICATIONS.

ART. 28. All members and fellows must forward to the Secretary of the proper Section or to the Permanent Secretary, as early as possible, and when practicable before the convening of the Association, full titles of all the papers which they propose to present during the meeting, with a statement of the time that each will occupy in delivery, and also such abstracts of their contents as will give a general idea of their nature; and no title shall be considered by a Sectional Committee until an abstract of the paper or the paper itself has been received.

ART. 29. If the author of any paper be not ready when called upon, in the regular order of the official program, the title may be dropped to the bottom of the list.

ART. 30. Whenever practicable the proceedings and discussions at General Sessions, Sections and Subsections, shall be reported by professional reporters, but such reports shall not appear in print as the official reports of the Association unless revised by the Secretaries.

PRINTED PROCEEDINGS.

ART. 31. The Permanent Secretary shall have the Proceedings of each meeting printed in an octavo volume as soon after the meeting as possible, beginning one month after adjournment. Authors must prepare their papers or abstracts ready for the press, and these must be in the hands of the Secretaries of the Sections before the final adjournment of the meeting, otherwise only the titles will appear in the printed volume. The Council shall have power to order the printing of any paper by abstract or title only. Whenever practicable, proofs shall be forwarded to authors for revision. If any additions or substantial alterations are made by the author of a paper after its submission to the Secretary, the same shall be distinctly indicated. Illustrations must be provided for by the authors of the papers, or by a special appropriation from the Council. Immediately on publication of

the volume, a copy shall be forwarded to every member and fellow of the Association who shall have paid the assessment for the meeting to which it relates, and it shall also be offered for sale by the Permanent Secretary at such price as may be determined by the Council. The Council shall also designate the institutions to which copies shall be distributed.

Local Committee.

Art. 32. The Local Committee shall consist of persons interested in the objects of the Association and residing at or near the place of the proposed meeting. It is expected that the Local Committee, assisted by the officers of the Association, will make all essential arrangements for the meeting, and issue a circular giving necessary particulars, at least one month before the meeting.

Library of the Association.

Art. 33. All books and pamphlets received by the Association shall be in charge of the Permanent Secretary, who shall have a list of the same printed and shall furnish a copy to any member or fellow on application. Members and fellows who have paid their assessments in full shall be allowed to call for books and pamphlets, which shall be delivered to them at their expense on their giving a receipt agreeing to make good any loss or damage, and to return the same free of expense to the Secretary at the time specified in the receipt given. All books and pamphlets in circulation must be returned at each meeting. Not more than five books, including volumes, parts of volumes, and pamphlets, shall be held at one time by any member or fellow. Any book may be withheld from circulation by order of the Council. [The Library of the Association was, by vote of the Council in 1895, placed on deposit in the Library of the University of Cincinnati, Ohio. Members can obtain the use of books by writing to the Librarian of the University Library, Cincinnati, Ohio.]

Admission Fee and Assessments.

Art. 34. The admission fee for members shall be five dollars in addition to the annual dues.

ART. 35. The annual dues for members and fellows shall be three dollars.

ART. 36. Any member or fellow who shall pay the sum of fifty dollars to the Association, at any one time, shall become a Life Member, and as such shall be exempt from all further assessments, and shall be entitled to the Proceedings of the Association All money thus received shall be invested as a permanent fund, the income of which, during the life of the member, shall form a part of the general fund of the Association; but, after his death, shall be used only to assist in original research, unless otherwise directed by unanimous vote of the Council.

ART. 37. All fees and dues must be paid to the Permanent Secretary, who shall give proper receipts for the same.

ACCOUNTS.

ART. 38. The accounts of the Permanent Secretary and of the Treasurer shall be audited annually by Auditors appointed by the Council.

ALTERATIONS OF THE CONSTITUTION.

ART. 39. No part of this Constitution shall be amended or annulled, without the concurrence of three-fourths of the members and fellows present in General Session, after notice given at a General Session of a preceding meeting of the Association.

MEMBERS AND FELLOWS

OF THE

AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE.

SURVIVING FOUNDERS.

[At the Brooklyn Meeting, 1894, a resolution was unanimously adopted by which all the surviving founders of the Association who have maintained an interest in science were made Honorary Life Members of the Association in recognition of their pioneer work in American Science.]

BOYÉ, MARTIN H., Coopersburg, Pa.
GIBBS, WOLCOTT, Newport, R. I.

PATRONS.

[Persons contributing one thousand dollars or more to the Association are classed as Patrons, and are entitled to the privileges of members and to the publications. The names of Patrons are to remain permanently on the list.]

THOMPSON, MRS. ELIZABETH, Stamford, Conn. (22). (Died July, 1899.)
LILLY, GEN. WILLIAM, Mauch Chunk, Pa. (28). (Died Dec. 1, 1893.)
HERRMAN, MRS. ESTHER, 59 West 56th St., New York, N. Y. (29).
McMILLIN, EMERSON, 40 Wall St., New York, N. Y. (37).

HONORARY FELLOWS.

[See ARTICLE VI of the Constitution.]

*ROGERS, PROF. WILLIAM B., Boston, Mass. (1). 1881. (Born Dec. 7, 1804. Died May 30, 1882.) **B E**
*CHEVREUL, MICHEL EUGENE, Paris, France. (35). 1886. (Born Aug. 31, 1786. Died April 9, 1889.) **C**
*GENTH, DR. F. A., Philadelphia, Pa. (24). 1888. (Born May 17, 1820. Died Feb. 2, 1892.) **C E**

*Hall, Prof. James, Albany, N. Y. (1). 1890. (Born in 1811. Died Aug. 7, 1898.)
*Gould, Dr. Benjamin Apthorp, Cambridge, Mass. (2). 1895. (Born Sept. 27, 1824. Died Nov. 26, 1896.) **A B**
*Leuckart, Prof. Rudolf. (44). 1895. (Born in Helmstedt, Braunschweig, Germany, Oct. 7, 1823. Died in Leipzig, Feb. 7, 1898.) **F**
*Gibbs, Prof. Wolcott, Newport, R. I. (1). 1896. **B C**
*Warington, Robert, F. R. S., Rothamsted, Harpenden, England. (40). 1899. **C**
*Westinghouse, George, Pittsburg, Pa. (50). 1902. **D**

MEMBERS AND FELLOWS.

The names designated by an asterisk (*) are those of Fellows. (See Article IV of the Constitution.) The number in parenthesis indicates the meeting at which the Member joined the Association; the date following is the year when made a Fellow; the black letters at end of line are those of the Sections to which the Member or Fellow belongs. When the name is given in small capitals, it designates that the Member or Fellow is also a Life Member. Any Member or Fellow may become a Life Member by the payment of fifty dollars. The income of the money derived from a life membership is used for the general purposes of the Association during the life of the Member; afterwards it is to be used to aid in original research. Life Members are exempt from the annual assessment, and are entitled to the publications. The names of Life Members are printed in small capitals in the regular list of Members and Fellows.

The Constitution requires that the names of all Members two years in arrears shall be omitted from the list, but their names will be restored on payment of arrearages. Members not in arrears are entitled to the publications of the Association, including the journal *Science*.

*Abbe, Cleveland, Professor of Meteorology, Weather Bureau, U. S. Dept. Agriculture, Washington, D. C. (16). 1874. **A B**
*Abbe, Cleveland, Jr., U. S. Geological Survey, Washington, D. C. (44). 1899. **E**
*Abbe, Dr. Robert, 13 W. 50th St., New York, N. Y. (36). 1892.
*Abbot, Charles G., Smithsonian Institution, Washington, D. C. (49). 1902. **B**
Abbot, E. Stanley, M. D., First Assistant Physician, McLean Hospital, Waverley, Mass. (54). **K**
Abbot, Henry L., Brigadier-General, U. S. A., Retired, 23 Berkeley St., Cambridge, Mass. (54). **B D**
*Abbott, Alexander C., Univ. of Penna., Philadelphia, Pa. (52). 1905. **K**
Abbott, Frank L., Professor of Physical Science, State Normal School, Greeley, Colo. (50). **B E**
Abbott, Theodore Sperry, C. E., Saltillo, Coahuila, Mexico. (52). **D**
*Abel, John J., Professor of Pharmacology, Johns Hopkins University, Baltimore, Md. (51). 1902. **C**

Abraham, Abraham, care of Abraham & Straus, Brooklyn, N. Y. (43).

Abrams, LeRoy, N. Y. Botanical Garden, Bronx Park, New York, N Y (54). G

*Acheson, Edward Goodrich, President of the International Acheson Graphite Co., Niagara Falls, N. Y. (50). 1903. C

*Adams, Charles C., University of Michigan, Ann Arbor, Mich. (50). 1903. F

Adams, Charles Francis, Head of Science Department, Central High School, Detroit, Mich. (53). B

Adams, Comfort A., 13 Farrar St., Cambridge, Mass. (47). B

Adams, Cyrus C., 416 W. 118th St., New, York N. Y. (54). E

Adams, C. F., Entomologist, Univ. Arkansas, Fayetteville, Ark. (54). F

Adams, Edward Dean, 1414–15 Empire Bldg., New York, N. Y. (49).

Adams, Frederick C., Mechanic Arts High School, Boston, Mass. (50). B C

Adams, John W., Prof. of Physics, McKinley Manual Training School, Washington, D. C. (54). B G

Adams, Orr J., Telluride, Colo. (53). C

Adams, Matthew Prior, Instructor in Physics and Chemistry, State Normal School, New Britain, Conn. (54). B C

Adler, Cyrus, Smithsonian Institution, Washington, D. C. (54). H

Adler, Felix, M. D., 123 E. 60th St., New York, N. Y. (54). K

*Adler, Isaac, M. D., 22 E. 62d St., New York, N. Y. (49). 1903. K

*Adriance, John S., 105 E. 39th St., New York, N. Y. (39). 1895. C

Agnew, P. G., Pontiac, Mich. (54). B

*Aguilera, José G., Director of the Geological Institute of Mexico, Mexico City, Mexico. (53). 1905. E

Ailes, Hon. Milton E., Riggs National Bank, Washington, D. C. (52). I

Ainsworth, Herman Reeve, M. D., Addison, N. Y. (51). I K

Aitken, Robert G., Lick Observatory, Mt. Hamilton, Cal. (53) A

Akeley, Lewis E., Professor of Physics and Chemistry, University of South Dakota, Vermillion, S. Dak. (51). B C

Albaugh, Maurice, Secretary of the Crescent Metallic Fence Stay Co., Covington, Ohio. (51). D

Albert, Harry Lee, Professor of Biology, State Normal School, Cape Girardeau, Mo. (53). F G

Albrecht, Emil Poole, Secretary of The Bourse, 1523 N. 17th St., Philadelphia, Pa. (51). A D

Albrecht, Sebastian, Lick Observatory, Mt. Hamilton, Cal. (52). A

Albree, Chester B., Mechanical Engineer, 14–30 Market St., Allegheny, Pa. (50). D

*Alden, John, Pacific Mills, Lawrence, Mass. (36). 1898.

*Alderson, Victor C., President Colorado School of Mines, Golden, Colorado. (50). 1903. D

Aldrich, Truman Heminway, 1739 P St., N.W., Washington, D. C. (54). E

*Aldrich, Wm. S., Director, Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y. (43). 1897. D

Alexander, Chas. Anderson, M. E., Johnston Harvester Co., 10 Vine St., Batavia, N. Y. (50). D

Alexander, Curtis, Mining Engineer, Cedral, San Luis Potosi, Mexico. (50). E

Alexander, George E., Chemist and Mining Engineer, 1736 Champa St., Denver, Colo. (50). C D

Alexander, Harry, E. E., M. E., 18 and 20 W. 34th St., New York, N. Y. (50). D

Aley, Robert J., Indiana Univ., Bloomington, Ind. (49).

Allabach, Miss Lulu F., Instructor in Biology and Zoology. Central State Normal School, Lock Haven, Pa. (52). F

Allan, Chas. F., Newburgh, N. Y. (50). B E

Allderdice, Wm. H., Lieutenant-Commander U. S. Navy, Navy Dept., Washington, D. C. (33). D

Alleman, Gellert, Ph. D., Swarthmore College, Swarthmore, Pa. (50). C

Allen, Bennet Mills, Instructor in Anatomy, University of Wisconsin, Madison, Wis. (54). F K

Allen, Charles Metcalf, Assistant Prof. of Experimental Engineering, Worcester Polytechnic Institute, Worcester, Mass. (52). D

Allen, Edwin West, Editor of *Experiment Station Record*, U. S. Dept. Agriculture, Washington, D. C. (52). I

*Allen, Frank, Ph. D., Professor of Physics, Univ. of Manitoba, Winnipeg, Manitoba. (49). 1903. B

Allen, Hon. F. I., Commissioner of Patents, Washington, D. C. (52). I

*Allen, Glover Morrill, Secretary Boston Soc. Nat. Hist., Perkins Hall 68, Cambridge, Mass. (52). 1905. F

Allen, H. Jerome, M. D., 421 H St., N.E., Washington, D. C. (51). K

Allen, Lyman Richards, Instructor in Geography and History, State Normal School, North Adams, Mass. (54). E

Allen, Richard H., Chatham, N. J. (49).

Allen, Walter S., 34 S. Sixth St., New Bedford, Mass. (39). C I

*Allis, Edward Phelps, Jr., Palais Carnolès, Menton, France. (52). 1905. F

Allison, Andrew, Ellisville, Miss. (54). F G

Allison, C. Edward, M. D., Elysburg, Pa. (51). K

Allison, Hendery, M. D., 260 West 57th St., New York, N.Y. (50). K

Almond, Thomas R., M. E., 83–85 Washington St., Brooklyn, N. Y. (51). D

*Almy, John E., Ph. D., Instructor in Physics, University of Nebraska, Lincoln, Neb. (50). 1901. B

Alpers, Wm. C., 45 West 31st St., New York, N. Y. (50). **I**

Alsop, E. B., 1502 20th St., N. W., Washington, D. C. (50). **D**

Alspach, E. F., 455 West Sixth Ave., Columbus, O. (48). **H**

Altamirano, Dr. Fernando, Instituto Medico Nacional, Esquina de Balderas y Ayuntamiento num 1202, Mexico, D. F. (53). **G**

Alwine, John, Jr., Associate Manager Baltimore Chrome Works, 1348 Block St., Baltimore, Md. (54). **C**

*Alwood, Wm. B., Charlottesville, Va. (39). 1891. **F**

*Ames, Oakes, Assistant Director of the Botanic Garden of Harvard University, North Easton, Mass. (50). 1905. **G**

Ami, H. M., Geological Survey of Canada, Ottawa, Ontario, Canada, (54). **E**

Amweg, Frederick James, Engineer and Manager, American-Hawaiian Engineering and Construction Co., Ltd., 218–222 Rialto Building, San Francisco, Cal. (51). **D**

Anders, Howard S., M. D., 1836 Wallace St., Philadelphia, Pa. (51). **K**

Anderson, A. J. C., 127 Water St., New York, N. Y. (49).

*Anderson, Alexander P., American Cereal Co., Railway Exchange Building, Chicago, Ill. (45). 1899. **G**

Anderson, Prof. Douglas S., Tulane Univ., New Orleans, La. (49). **B D**

Anderson, Edwin Clinton, M. D., 726 Market St., Chattanooga, Tenn. (51). **K**

Anderson, Frank, E. M., 255 Second East St., Salt Lake City, Utah. (50). **D E**

Anderson, Frank P., Epworth, Iowa. (46).

Anderson, J. Hartley, M. D., 4630 Fifth Ave., Pittsburg, Pa. (50). **K**

Anderson, William G., M. D., Director Yale University Gymnasium, New Haven, Conn. (52). **H K**

Anderson, Winslow, M. D., President of College of Physicians and Surgeons of San Francisco, 1025 Sutter St., San Francisco, Cal. (51). **K**

Andrews, Clement Walker, Librarian of The John Crerar Library, Chicago, Ill. (53). **C**

*Andrews, Frank Marion, Ph. D., Asst. Professor Botany, Indiana University, Bloomington, Ind. (52). 1903. **G**

Andrews, Wm. Edward, Principal Township High School, 700 South Clay St., Taylorville, Ill. (52). **D**

Andrews, William Symes, care Gen'l Elec. Co., Schenectady, N. Y. (50). **D E**

Angle, Dr. Edward H., 1023 North Grand Ave., St. Louis, Mo. (53). **F**

Annear, John Brothers, 1028 Regent St., Boulder, Colo. (50). **C.**

Anthony, Richard A., 122–124 Fifth Ave., New York, N. Y. (49).

*Anthony, Prof. Wm. A., Cooper Union, New York, N. Y. (28). 1880. B

Apple, Joseph H., President of the Woman's College, Frederick, Md. (52). I

*Appleton, John Howard, Professor of Chemistry, Brown University, Providence, R. I. (50). 1901. C

Archer, George Frost, 31 Burling Slip, New York, N. Y. (50). D

Archibald, Raymond Clare, Sackville, New Brunswick, Canada. (54). A

Argall, Philip, Mining and Metallurgical Engineer, 730 Majestic Building, Denver, Col. (54). C E

Armitage, Thomas L., M. D., Princeton, Minnesota. (51). K

*Armsby, Henry Prentiss, Director Agrl. Expr. Station, State College, Centre Co., Pa. (52). 1903. C

*Arnold, Bion Joseph, 4128 Prairie Ave., Chicago, Ill. (50). 1903. D

Arnold, Delos, Olcott Place, Pasadena, Cal. (51).

Arnold, Ernst Hermann, M. D., Director New Haven Normal School of Gymnastics, 46 York Square, New Haven, Conn. (52). K

Arnold, Mrs. Francis B., 101 W. 78th St., New York, N. Y. (49).

Arnold, Ralph, U. S. Geological Survey, Washington, D. C. (51). E

*Arthur, J. C., D. Sc., Botanist Agric. Exper. Sta., Purdue Univ., Lafayette, Ind. (21). 1883. G

Ascham, Louis, 420 W. Willow St., Chippewa Falls, Wis. (54). F G

Asdale, William James, M. D., Professor of Gynecology, Western Penna. Medical College, Pittsburg, Pa. (51). K

Ashbrook, Donald Sinclair, 3614 Baring St., Philadelphia, Pa. (51). C

Ashcraft, A. M., Ph.D., P. O. Box 742, Baltimore, Md. (52).

*Ashley, George Hall, Professor of Biology and Geology, College of Charleston, Charleston, S. C. (51). 1903. E F

*Ashmead, Wm. H., Department of Insects, U. S. National Museum, Washington, D. C. (40). 1892. F

Ashton, Charles Hamilton, Assistant in Mathematics, University of Kansas, Lawrence, Kansas. (53). A

Aspinwall, John, 290 Broadway, New York, N. Y. (49).

Atkins, Prof. Martin D., 269 Forest Ave., River Forest, Ill. (48). B

*Atkinson, Edward, 31 Milk St., Boston, Mass. (29). 1881. D I

*Atkinson, George F., Cornell University, Ithaca, N. Y. (39). 1892. G

Atkinson, John B., Earlington, Ky. (26). D

*Atwater, W. O., Professor of Chemistry, Wesleyan Univ., Middletown, Conn. (29). 1882. C

*Atwell, Charles B., Northwestern Univ., Evanston, Ill. (36). 1890. G

*Auchincloss, Wm. S., Atlantic Highlands, N. J. (29). 1886. A D

*Austen, Prof. Peter T., 80 Broad St., New York, N. Y. (44). 1896. C

Austin, C. F., Horticulturist, Estacion Central Agronomica, Santiago de las Vegas, Cuba. (54). G

*Avery, Elroy M., Ph. D., LL.D., 657 Woodland Hills Ave., Cleveland, Ohio. (37). 1889. B

Ayer, Edward Everett, Railway Exchange Bldg., Chicago, Ill. (37). H

Ayer, James I., 5 Main St. Park, Malden, Mass. (50). D

*Ayers, Howard, President Univ. of Cincinnati, Cincinnati, Ohio. (49). 1901. F

*Ayres, Dr. Brown, President of University of Tennessee, Knoxville, Tenn. (31). 1885. B

Ayres, Horace B., Kimberley, Minn. (40).

Babbitt, James A., M. D., Assoc. Prof. Physiology, Haverford College, Haverford, Pa. (54). K

Babcock, Charles A., Supt. Schools, Oil City, Pa. (52). F

*Babcock, Prof. S. Moulton, 432 Lake St., Madison, Wis. (33). 1885. C

Babcock, W. Wayne, M. D., 3302 No. Broad St., Philadelphia, Pa. (54). K

Baber, Zonia, Instructor in Geography, University of Chicago, Chicago, Ill. (54). E

Bacon, Arthur Avery, Professor of Physics, Hobart College, Geneva. N. Y. (53). B

Baerecke, John F., M. D., Professor of Biology, Stetson University, DeLand, Fla. (50). F K

Bagby, J. H. C., Dept. Physical Science, Hampden-Sidney College, Hampden-Sidney, Va. (50). B

*Bagg, Rufus Mather, Jr., Ph. D., High School, Brockton, Mass. (49). 1903. E

BAGGALEY, RALPH, Pittsburg, Pa. (50). D

*Bailey, E. H. S., Professor of Chemistry, Univ. of Kansas, Lawrence, Kan. (25). 1889. C E

Bailey, E. P., In charge Department of Geology and Geography, Brockton High School, Brockton, Mass. (52). E

Bailey, Frank H., Com'dr, U. S. N., 15 Halsey St., Brooklyn, N. Y. (52). D

*Bailey, Solon Irving, Associate Prof. Astronomy, Harvard Observatory, Cambridge, Mass. (50). 1901. A

*Bailey, Vernon, Department of Agriculture, Washington, D. C. (52). 1904. F

*Bain, Samuel M., Professor of Botany, University of Tennessee, Knoxville, Tenn. (50). 1902. G

*Bair, Joseph Hershey, Ph. D., University of Colorado, Boulder, Colo. (52). 1905. H K

*Baird, John Wallace, 1128 McCulloh St., Baltimore, Md. (53). 1905. H

Baird, Lucy H., 1703 Rittenhouse St., Philadelphia, Pa. (54). I

Baird, Robert Logan, Assistant in Laboratories, Oberlin College, Oberlin, Ohio. (53). F

Baker, A. G., Springfield, Mass. (44).

Baker, Carl F., Botanist, Estacion Central Agronomica Santiago de las Vegas, Cuba. (54). G

*Baker, Frank, M. D., 1728 Columbia Road, Washington, D. C. (31). 1886. F H K

Baker, Frederic, 815 Fifth Ave., New York, N. Y. (49).

Baker, Hugh P., Yale Forest School, New Haven, Conn. (51). G

*Baker, James H., LL. D., President of the University of Colorado, Boulder, Colo. (50). 1903. I

Baker, Robt. H., Assistant in Astronomy, Observatory House, Amherst, Mass. (54). A

Baker, Smith, M. D., 296 Rutger St., Utica, N. Y. (54). K

Bakewell, Charles Montague, Prof. of the History of Philos., University of California, Berkeley. Cal. (54). I

Balch, Alfred William, Assistant Surgeon, U. S. N., Naval Museum of Hygiene and Medical School, Washington, D. C. (52). C K

*BALCH, EDWIN SWIFT, 1412 Spruce St., Philadelphia, Pa. (51). 1903. E H

Balch, Francis Noyes, Prince St., Jamaica Plain, Mass. (50). F

Balch, Samuel W., 67 Wall St., New York, N. Y. (43).

Baldwin, A. E., M. D., 34–36 Washington St., Chicago, Ill. (54). K

Baldwin, Mrs. G. H., 3 Madison Ave., Detroit, Mich. (34). H

Baldwin, Helen, 53 East 20th St., New York, N. Y. (54). C

Baldwin, Herbert B., 9–11 Franklin St., Newark, N. J. (43).

*Baldwin, Prof. J. Mark, Princeton, N. J. (46). 1898. H

*BALDWIN, HON. SIMEON E., Associate Judge of Supreme Court of Errors, New Haven, Conn. (50). 1901. I

*BALDWIN, S. PRENTISS, 736 Prospect St., Cleveland, Ohio. (47). 1900. E

*Ball, Carleton R., U. S. Dept. Agriculture, Washington, D. C. (49). 1902. G

*Ball, Elmer Darwin, Professor of Zoölogy and Entomology, State Agricultural College, Logan, Utah. (50). 1903. F

Ball, Miss Helen Augusta, 43 Laurel St., Worcester, Mass. (50). F

Ballard, C. A., Curator of Museum, State Normal School, Moorhead, Minn. (51).

*Ballard, Harlan H., 50 South St., Pittsfield, Mass. (31). 1891. E F

*Balliet, Thomas M., New York Univ., Washington Square, New York, N. Y. (48). 1903. H I

Bancroft, Frank Watts, Ph. D., Instructor in Physiology, University of California, Berkeley, Cal. (50). F K

Bancroft, J. Sellers, M. E., 919 Pine St., Philadelphia, Pa. (51). D

*Bancroft, Wilder Dwight, Professor of Chemistry, Cornell University, Ithaca, N. Y. (50). 1901. B C

BANGS, LEMUEL BOLTON, M. D., 39 E. 72d St., New York, N. Y. (36).

*Bangs, Outram, 240 Beacon St., Boston, Mass. (47). 1900. F

*Banker, Howard J., Prof. Biology, Depauw Univ., Greencastle, Ind. (51). 1905. G

Banks, William C., Electrician, Gordon Battery Co., 439 E. 144th St., New York, N. Y. (50). D

Banta, Arthur M., Univ. of Indiana, Bloomington, Ind. (53). F

Barbour, Miss Carrie Adeline, Dept. of Geology, Univ. of Nebraska, Lincoln, Neb. (53). E

*Barbour, Erwin Hinckley, Prof. of Geology, Univ. of Nebraska, Lincoln, Neb. (45). 1898. E

Barbour, Thomas, Agassiz Museum, Cambridge, Mass. (50). F

Barck, Dr. Carl, 2715 Locust St., St. Louis, Mo. (52).

*Bardeen, Charles Russell, Professor of Anatomy, University of Wisconsin, Madison, Wis. (50). 1901. F K

Bardeen, Charles William, 406 So. Franklin St., Syracuse, N.Y. (52).

Barkan, Adolph, M. D., LL. D., 2209 Laguna St., San Francisco, Cal. (51). K

*BARKER, PROF. G. F., 3909 Locust St., Philadelphia, Pa. (13). 1875. B C

Barker, Mrs. Martha M., 42 Eleventh St., Lowell, Mass. (31). E H

Barlow, John, Professor of Zoölogy, R. I. College of A. and M. Arts, Kingston, R. I. (51). F

*Barnard, Edward E., Yerkes Observatory, Williams Bay, Wis. (26). 1883. A

*Barnes, Charles Reid, Ph. D., Univ. of Chicago, Chicago, Ill. (33). 1885. G

Barnes, Edward W., Box 446, New York, N. Y. (49).

Barnett, Mrs. Lelia Jefferson, Stanford University, Cal. (52). A

Barnett, Robert Crary, 3023 East 20th St., Kansas City, Mo. (51). D

Barnhart, Arthur M., 185 Monroe St., Chicago, Ill. (42).

*Barnhart, John H., M. D., Tarrytown, N. Y. (49). 1903. G

Barnsley, George Thomas, C. E., Oakmont, Pa. (51). D

*Barnum, Miss Charlotte C., Ph. D., U. S. Coast and Geodetic Survey, Washington, D. C. (36). 1896. **A**

Barr, Charles Elisha, Professor of Biology, Albion College, Albion, Mich. (50). **F**

*Barr, John Henry, care of Smith Premier Typewriter Co., Syracuse, N. Y. (51). 1903. **D**

*Barrell, Joseph, 173 Edwards St., New Haven, Conn. (51). 1905. **E**

Barrie, Dr. George, 2131 Mass. Ave., N.W., Washington, D. C. (49). **H I**

Barringer, Daniel Moreau, Geologist and Mining Engineer, 460 Bullitt Building, Philadelphia, Pa. (50). **D E**

*Barrows, Walter B., Professor of Zoölogy and Geology, Agricultural College, Mich. (40). 1897. **F**

Bartholomew, C. E., Instructor in Zoölogy, Iowa State College, Ames, Iowa. (54). **F**

*Bartlett, Prof. Edwin J., Dartmouth College, Hanover, N. H. (28). 1883. **C**

Bartlett, Francis, 40 State St., Boston, Mass. (50). **I**

Bartlett, George Miller, Instructor in Drawing and Descriptive Geometry, University of Michigan, Ann Arbor, Mich. (52). **B**

*Bartley, Elias H., M. D., 21 Lafayette Ave., Brooklyn, N. Y. (33). 1894. **C**

*Barton, G. E., 227 Pine St., Millville, N. J. (46). 1898. **C**

*Barton, George Hunt, Dept. of Geology, Mass. Inst. Tech., Boston, Mass. (47). 1900. **E**

Barton, Philip Price, E. E., Sup't Niagara Falls Power Co., 127 Buffalo Ave., Niagara Falls, N. Y. (50). **D E**

*Barton, Samuel M., Ph. D., The Univ. of the South, Sewanee, Tenn. (43). 1899. **A**

Bartow, Edward, Ph. D., Kansas State University, Lawrence, Kan. (47). **C**

Bartsch, Paul, Ph. D., Instructor in Zoology, George Washington Univ., Washington, D. C. (52). **F**

*Barus, Carl, Ph. D., Wilson Hall, Brown Univ., Providence, R. I. (33). 1887. **B**

Barwell, John William, Waukegan, Ill. (47).

*Bascom, Miss Florence, Bryn Mawr College, Bryn Mawr, Pa. (42). 1897. **E**

Bashore, Dr. Harvey B., West Fairview, Pa. (46). **E**

*Baskerville, Charles, Professor of Chemistry, College of the City of New York, New York, N. Y. (41). 1894. **C E**

Baskett, James Newton, Mexico, Mo. (50). **F I**

Basquin, Olin H., Associate Professor of Physics, Northwestern University, Evanston, Ill. (53). **B D**

Bassett, Carroll Phillips, Ph. D., Civil and Consulting Engineer, Summit, N. J. (51). **D**

Bates, Henry H., Ph. D., The Portland, Washington, D. C. (52). A B D

*Bates, Rev. John Mallery, Red Cloud, Neb. (51). 1903. G I

*Bauer, Louis A., Ph. D., U. S. C. and G. Survey, Washington, D. C. (40). 1892. A B

Baumgardt, B. R., 626 W. 30th Street, Los Angeles, Cal. (51). A

*Bausch, Edw., P. O. Drawer 1033, Rochester, N. Y. (26). 1883. A B C F

Bausch, Henry, P. O. Drawer 1033, Rochester, N. Y. (41).

*Bawden, H. Heath, Professor of Psychology and Philosophy, Vassar College, Poughkeepsie, N. Y. (51). 1905. F

Baxter, Gregory Paul, Instructor in Quantitative Analysis, Harvard University, Cambridge, Mass. (54). C

Baxter, James Phinney, President, Maine Historical Society, Portland, Maine. (50). H I

*Bayley, Wm. Shirley, Prof. Geology, Colby College, Waterville, Maine. (53). 1905. E

Beach, Miss Alice M., St. Anthony Park, Minn. (50). F

Beach, Charles Coffing, M. D., 54 Woodland St., Hartford, Conn. (50). F K

Beach, Henry Harris Aubrey, M. D., 28 Commonwealth Ave., Boston, Mass. (50). F K

*Beach, Spencer Ambrose, N. Y. Agric. Exper. Station. Geneva, N. Y. (41). 1900. G

Beach, William Harrison, Teacher of History and Civics, East Division High School, 229 Pleasant St., Milwaukee, Wis. (52).

Beahan, Willard, Division Engineer, C. & N. W. Ry., 220 W. 6th St., Winona, Minn. (51). D

Beal, James Hartley, Professor of Pharmacy, Scio College of Pharmacy, Scio, Ohio. (54). C

Beal, Walter Henry, Assistant, Office of Experiment Stations, U. S. Dept. Agriculture, Washington, D. C. (52).

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Beatty, James W. F., Pitcairn, Pa. (51).

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Bigelow, Henry Bryant, Cohasset, Mass. (52).

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*Bigelow, Robert Payne, Ph. D., Mass. Institute of Technology, Boston, Mass. (51). 1903. F

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*Blake, Francis, Auburndale, Mass. (23). 1874. A B

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Briggs, Wallace Alvin, M. D., 1005 K St., Sacramento, Cal. (51). K
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Brigham, William T., Director of B. P. Bishop Museum of Polynesian Ethnology and Natural History, Honolulu, T. H. (54). H
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BRITTON, WILEY, Special Pension Examiner, Springfield, Mo. (40). F
Britton, Wilton Everett, Ph. D., State Entomologist, Agricultural Ex. Sta., New Haven, Conn. (54). F
Broadhurst, Jean, Inst. in Botany, N. J. Normal and Model School, Trenton, N. J. (54). G
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Brooks, Charles, Botanical Laboratory, University of Missouri, Columbia, Mo. (53). G
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Brooks, Rev. Earle Amos, Waverly, W. Va. (50). F
Brooks, J. Ansel, Instructor in Mech. Drawing, Brown University, Providence, R. I. (54). D
Brooks, James C., 430 Washington Ave., Philadelphia, Pa. (54). D
*Brooks, Wm. Keith, Ph. D., Johns Hopkins Univ., Baltimore, Md. (52). 1903. F
Brooks, Prof. Wm. P., Amherst, Mass. (38). C F
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Brown, Calvin S., D. Sc., Ph. D., Glass, Tenn. (54). E F G
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*Bull, Prof. Storm, University of Wisconsin, Madison, Wis. (44). 1897. D

Bullard, Warren Gardner, Ph. D., Associate Professor of Mathematics, Syracuse University, Syracuse, N. Y. (50). A

Bullene, Mrs. Emma F. Jay, 329 16th St., Denver, Colo. (50). H

*Bumpus, H. C., Am. Mus. Nat. Hist., New York, N. Y. (49). 1900.
*Burbank, Luther, Santa Rosa, Cal. (50). 1901. G
Burbidge, Frederick, 510 Empire State Building, Spokane, Wash. (50). D E
Burchard, Anson W., 44 Broad St., New York, N. Y. (51). D
Burdick, Lewis Dayton, Oxford, N. Y. (52).
Burgess, Albert F., State House, Columbus, O. (54). F
*Burgess, Edward S., 11 W. 88th St., New York, N. Y. (47). 1901. G
*Burgess, Thomas J. W., M. D., Medical Supt. Protestant Hospital for the Insane, Montreal, Can. (38). 1889. G
Burke, M. D., C. E., 404 Pike Bldg., Cincinnati, Ohio. (50). A B C D E
Burke, Robert E.. Boston Normal School. Boston, Mass. (50). C
Burkett, Charles William, Ph. D., Professor of Agriculture, N. C. College of Agriculture and Mechanic Arts, West Raleigh, N. C. (53). C
Burnette, F. H., Professor of Horticulture, Louisiana University, Baton Rouge, La. (54). F G
Burnham, George, Jr., C. E., Burnham, Williams & Co., Baldwin Locomotive Works, 214 N. 34th St. Philadelphia, Pa. (51). D
*Burr, Prof. William H., Columbia University, New York, N. Y. (31). 1883.
Burrell, Rámon Haddock, M. D., Creighton, Neb. (51). K
*Burrill, Thomas J., Professor of Botany, University of Illinois, Urbana, Ill. (53). 1905. G
Burroughs, Paul R., Allison, Iowa. (50). C
*Burt, Edward Angus, Ph. D., Professor of Natural History, Middlebury College, Middlebury, Vt. (50). 1901. G
Burton, Prof. Alfred E., Mass. Inst. Technology, Boston, Mass. (40). E
Burton, E. F., Demonstrator in Physics, University of Toronto, Toronto, Ontario, Canada. (53). B
*Burton, Hon. Theodore E., Cleveland, Ohio. (52). 1905. I
*Burton-Opitz, Russell, Instructor in Physiology, Columbia University, New York, N. Y. (52). 1905. K
Busch, Frederick Carl, M. D., 145 Allen St., Buffalo, N. Y. (49).
Bush, John C. F., M. D., Wahoo, Neb. (51). K
*Bushnell, D. I., Jr., Assistant in Archæology, Peabody Museum, Cambridge, Mass. (52). 1903. H
*Butler, Amos W., Secretary Board of State Charities, Indianapolis, Ind. (30). 1885. F H
Butler, Matthew Joseph, Asst. Chief Engineer Trans-Continental Railway, 877 Dorchester St., Montreal, P. Q., Canada. (51). D
Butterfield, Arthur Dexter, Professor of Mathematics and Mechanics, University of Vermont, Burlington, Vt. (50). A D
Butterfield, Elmore E., Instructor in Pathology, Univ. of Michigan, Ann Arbor, Mich. (53). F

Butts, Edward Pontany, C. E., Chief Engineer, Am. Writing Paper Co., Holyoke, Mass. (51). D

Buxton, Bertram H., Professor Experimental Medicine, Cornell Medical College, 414 East 26th St., New York, N. Y. (54). F G

Byrnes, Owen, Mining Engineer, P. O. Box 131, Marysville, Montana. (51). D E

Cabot, Samuel, Manufacturing Chemist, 70 Kilby St., Boston, Mass. (50). C

Cady, Hamilton Perkins, Assistant Professor of Chemistry, University of Kansas, Lawrence, Kansas. (52). B C

Cady, Walter G., Ph. D., Wesleyan Univ., Middletown, Conn. (49). B

*Cain, William, Professor of Mathematics, University of North Carolina, Chapel Hill, N. C. (50). 1901. A D

*Cajori, Florian, Professor of Mathematics, Colorado College, Colorado Springs, Colo. (50). 1901. A

*Caldwell, Prof. Otis W., State Normal School, Charleston, Ill. (49). 1902. G

Calhoun, Fred H. H., Ph. D., Clemson College, S. C. (54). E

*Calkins, Gary N., Ph. D., Adjunct Professor of Zoölogy, Columbia University, New York, N. Y. (49). 1901. F

Calkins, Marshall, M. D., 14 Maple St., Springfield, Mass. (29).

*Calvert, Philip P., Ph. D., Instructor in Zoology, Biological Hall, University of Pennsylvania, Philadelphia, Pa. (50). 1903. F

*Calvert, Prof. Sidney, Univ. of Missouri, Columbia, Mo. (47). 1903. C

*Calvin, Prof. Samuel, Dir. Iowa Geol. Surv., Iowa City, Iowa. (37). 1889. E F

*Cameron, Frank K., Ph. D., Chemist, Bureau of Soils, U. S. Dept. Agriculture, Washington, D. C. (49). 1901. C

Cameron, John E., Professor Natural History, Cedar Rapids High School, Cedar Rapids, Ia. (54). G

Cammann, Hermann H., 51 Liberty St., New York, N. Y. (49).

*Campbell, Douglas H., Professor of Botany, Stanford University, Cal. (34). 1888. G

*Campbell, Henry Donald, Professor Geology and Biology, Washington and Lee University, Lexington, Va. (52). 1905. E F G

Campbell, Leslie Lyle, Ph. D., Harvard University, Cambridge, Mass. (48).

*Campbell, Marius Robison, U. S. Geological Survey, Washington, D. C. (52). 1905. E

*CAMPBELL, WILLIAM WALLACE, Director of Lick Observatory, Mt. Hamilton, Cal. (50). 1901. A

*Cannon, George Lyman, Instructor in Geology, Denver High School (No. 1), Denver, Colo. (39). 1901. E

*Cannon, W. A., Ph. D., Desert Botanical Laboratory, Tucson, Arizona. (52). 1905. **G**

Cannon, Walter Bradford, Asst. Prof. Physiology, Harvard University, Cambridge, Mass. (54). **K**

Canter, Hall, Professor of Chemistry, Randolph-Macon College, Ashland, Va. (54). **C**

Card, Fred. W., Professor of Horticulture, R. I. Coll. Agr. and Mech. Arts, Kingston, R. I. (45). **G**

Carey, Everett P., San Jose High School, Jan Jose, Cal. (50). **B C**

*Carhart, Prof. Henry S., Univ. of Michigan, Ann Arbor, Mich. (29). 1881. **B**

*Carleton, M. A., U. S. Dept. Agriculture, Washington, D. C. (42). 1894. **G**

Carlson, Anton Julius, Ph. D., Associate in Physiology, Univ. of Chicago, Chicago, Ill. (52). **K**

Carmalt, William Henry, Professor of Surgery, Yale University, New Haven, Conn. (54). **K**

Carnaghan, Edwin Dixon, Mechanical Engineer, Villa Corona, Mexico. (50). **D**

Carnegie, Thomas Morrison, Trustee of Carnegie Institute, Dungeness, Fernandina, Fla. (50). **F**

Carpenter, Ford A., U. S. Weather Bureau, San Diego, Cal. (44) **B**

Carpenter, Frances Ann, M. D., 521 South Hanover St., Baltimore, Md. (54). **K**

Carpenter, Franklin R., Ph. D., Mining Expert, 1420 Josephine St. Denver, Colo. (50). **D E**

*Carpenter, Louis G., Agric. College, Fort Collins, Colo. (32). 1889. **A B**

Carr, William Kearny, 1413 K St., N.W., Washington, D. C. (52).

Carr, William Phillips, M. D., 1418 L St., N.W., Washington, D. C. (51). **K**

*Carroll, James, M. D., 2147 F St., N.W., Washington, D. C. (50). 1903. **F K**

Carrow, Flemming, M. D., University of Michigan, Ann Arbor, Mich. (51). **K**

Carruth, John G., Indiana Ave. and Rosehill St., Philadelphia, Pa. (54). **D**

Carson, Lewis Clinton, Asst. Prof. of Philosophy, Indiana Univ., Bloomington, Ind. (54). **I**

Carson, Shelby Chadwick, M. D., Greensboro, Ala. (51). **K**

Carter, Henry C., 491 Bradford St., North Andover, Mass. (50).

Carter, James, M. D., Rawlins, Wyoming. (50). **E K**

CARTER, JAMES C., 277 Lexington Ave., New York, N. Y. (36).

*Carter, James Madison G., M. D., Waukegan, Ill. (39). 1895. **F**

Carter, John E., Knox and Coulter Sts., Germantown, Pa. (33). **B H**

Carter, Marion H., 504 West 143d St., New York, N. Y. (49).

Carty, John Joseph, Chief Engineer N. Y. Telephone Co., 18 Cortlandt St., New York, N. Y. (54). **D**

*Carus, Paul, Ph. D., Editor Open Court Pub. Co., 324 Dearborn St., Chicago, Ill. (40). 1895. **H**

Cary, Mrs. Elizabeth M. L., 184 Delaware Ave., Buffalo, N. Y. (45). **E**

Case, Eckstein, Case School of Applied Science, Cleveland, Ohio. (47).

Case, Ermine Cowles, Prof. of Chemistry and Geology, State Normal School, Milwaukee, Wis. (50). **B C E**

*Casey, Thomas L., Major of Engineers, U. S. A., P. O. Drawer 71, St. Louis, Mo. (38). 1892. **D F**

*Castle, W. E., Asst. Professor Zoölogy, Harvard Univ., Cambridge. Mass. (52). 1903. **F**

Cathcart, Miss J. R., care Munroe & Co., 7 Rue Scribe, Paris, France. (50).

*Catlin, Charles A., 133 Hope St., Providence, R. I. (33). 1895. **C**

*Cattell, H. W., M. D., 3709 Spruce St., Philadelphia, Pa. (50). 1901. **K**

*CATTELL, PROF. JAMES MCKEEN, Columbia Univ., New York. N. Y. (44). 1896. **B F H I**

Cerna, Dr. David, Monclova, Coahuila, Mexico. (51).

Chadbourn, Erlon R., Lewiston, Me. (29).

Chadwick, George Halcott, Geologist and Palæontologist, Ward's Nat. Science Establishment, 76 College Ave., Rochester, N. Y. (54). **E**

Chadwick, Leroy S., M. D., 1824 Euclid Ave., Cleveland, Ohio. (51).

*Chaillé, Stanford E., M. D., LL.D., Dean of Medical Department, Tulane University, New Orleans, La. (51). 1903. **K**

*Chamberlain, Charles Joseph, Dept. of Botany, University of Chicago, Chicago, Ill. (50). 1902. **G**

Chamberlain, Clark Wells, Professor of Physics, Denison University, Granville, Ohio. (53). **B**

Chamberlain, Frederic M., Bureau of Fisheries, U. S. Department of Commerce and Labor, Washington, D. C. (51). **F**

Chamberlain, Paul Mellen, Prof. of Mechanical Engineering, Lewis Institute, Chicago, Ill. (51). **D**

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*Chamberlin, T. C., Head of Dept. of Geology, Univ. of Chicago, Chicago, Ill. (21). 1877. **B E F H**

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Chambers, Will Grant, Professor of Psychology and Education, State Normal School, Greeley, Colo. (52). **H**

Chambliss, Charles E., Associate Professor of Zoology and Entomology, Clemson College, Clemson College, S. C. (51). **F**

Chancellor, Wm. E., Supt. of Schools, Paterson, N. J. (52).
*Chandler, Prof. C. F., School of Mines, Columbia University, New York, N. Y. (19). 1875. **C**
*Chandler, Charles Henry, Professor of Mathematics, Ripon College, Ripon, Wis. (28). 1883. **A**
Chandler, Clarence Austin, Mechanical Engineer, East Bridgewater, Mass. (52). **D**
Chandler, Elwyn Francis, Assistant Professor of Mathematics, University of North Dakota, University, N. Dak. (50). **A B**
Chandler, Richard E., Stillwater, Oklahoma. (46). **B D**
Chaney, Prof. Lucian W., Carleton College, Northfield, Minn. (45).
Chant, Clarence Augustus, Lecturer in Physics, University of Toronto, Toronto, Can. (54). **A B**
*Chanute, O., 413 E. Huron St., Chicago, Ill. (17). 1877. **D I**
Chapman, Robert Hollister, U. S. Geological Survey, Washington D. C. (52). **E**
Charles, Fred. L., Professor of Biology, Northern Illinois State Normal School, De Kalb, Ill. (52). **F G**
Charlton, Orlando Clarke, Professor of Biology and Geology, Kalamazoo College, Kalamazoo, Mich. (51). **E F G**
Chase, Mrs. Agnes, Dept. of Agriculture, Washington, D. C., (54). **G**
*Chase, Frederick L., Yale University Observatory, New Haven, Conn. (43). 1896. **A**
Chase, George Colby, President and Professor of Psychology and Logic Bates College, Lewiston, Me. (54). **K**
Chase, Harry Gray, Assistant Professor of Physics, Tufts College, Mass. (52). **B**
Chase, Ira Carleton, M. D., Fort Worth, Texas. (52).
Chase, R. Stuart, 53 Summer St., Haverhill, Mass. (18). **F**
*Chauvenet, Wm. M., Mining Engineer, 620 Chestnut St., St. Louis, Mo. (50). 1901. **C D**
*Cheesman, T. M., M. D., Garrison-on-Hudson, N. Y. (50) 1901. **K**
Cheever, Clarence A., M. D., 1531 Blue Hill Ave., Boston, Mass. (53). **G**
Cheney, Newel, Poland Center, N. Y. (52).
Cheney, Willard Colfax, Electrical Engineer, Portland, Oregon. (50). **D**
Chesnut, Victor King, Dept. of Chemistry, Montana Agrl. Ex. Sta., Bozeman, Mont. (54). **C G**
*Chester, Colby M., Rear Admiral, U. S. N., Superintendent Naval Observatory, Washington, D. C. (28). 1897. **E**
Chester, Wayland Morgan, Associate Professor of Biology, Colgate University, Hamilton, N. Y. (50). **F**

*Chickering, J. W., The Portner, Washington, D. C. (22). 1877. G I
Chilcott, Ellery Channing, Professor of Geology, Agricultural College, Brookings, S. D. (50). E
*Child, Charles Manning, Instructor in Zoology, University of Chicago, Chicago, Ill. (50). 1901. F
*Child, Clement D., Colgate Univ., Hamilton, N. Y. (44). 1899. B
Childs, James Edmund, Civil Eng., 300 W. 93d St., New York, N. Y. (51). D
Chisholm, A. Arthur, M. D., Kelseyville, Cal. (51). K
Chisholm, Hugh J., 813 Fifth Avenue, New York, N. Y. (50).
Chisolm, George E., 19 Liberty St., New York, N. Y. (50).
*Chittenden, Frank Hurlbut, U. S. Dept. Agriculture, Washington, D. C. (48). 1901. F
Chittenden, J. Brace, Department of Pure Mathematics, Brooklyn Polytechnic Institute, Brooklyn, N. Y. (53). A
*Chittenden, Russell H., Director of Sheffield Scientific School, Yale University, New Haven, Conn. (50). 1901. C F
Chittenden, Thomas A., Instructor in Mechanical Engineering, A. and M. College, W. Raleigh, N. C. (50). D
*Christie, James, Chief Mech. Engineer Am. Bridge Co., 100 Rochelle Ave., Wissahickon, Philadelphia, Pa. (33). 1894. D
Church, Arthur L., 500 N. Broad St., Philadelphia, Pa. (54).
Church, Royal Tyler, Turin, N. Y. (38). D F
*Churchill, William, care Corning Club, Corning, N. Y. (52). 1905. H
Churchill, William W., care of Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York, N. Y. (51). D
Churchward, Alexander, Schenectady, N. Y. (52).
*Chute, Horatio N., Instructor in Physical Sciences, High School, Ann Arbor, Mich. (34). 1889. A B C
*Cilley, Frank H., Mass. Inst. Technology, Boston, Mass. (49). 1901. A B D
*Clapp, Miss Cornelia M., Mt. Holyoke College, South Hadley, Mass. (31). 1883. F
Clapp, Frederick Gardner, U. S. Geological Survey, Washington, D. C. (51). E
Clark, Alexander S., Westfield, N. J. (33).
Clark, Arthur W., care J. Ellwood Lee Co. Conshohocken, Pa. (54).
Clark, Austin Hobart, 107 Audubon Road, Boston, Mass. (52). F
Clark, Miss Bertha May, Instructor in Physics, The Woman's College, Baltimore, Md. (52). B
Clark, Clarence Munroe, Bullitt Building, Philadelphia, Pa. (54). I
Clarke, Miss Cora H., 91 Mt. Vernon St., Boston, Mass. (47). F G
Clark, Edmund, 237 Steuben St., Brooklyn, N. Y. (50).
Clark, Ernest P., 58 Broad St., New York, N. Y. (50). 1901. D
Clark, Friend Ebenezer, Ph. D., Dept. of Chemistry, Penna. State College, State College, Pa. (51). C

*Clarke, Prof. F. W., U. S. Geol. Survey, Washington, D. C. (18). 1874. C

*Clark, Gaylord Parsons, Professor of Physiology, Syracuse University, Syracuse, N. Y. (50). 1901. F K

Clark, Herbert A., 1902 P St., Lincoln, Neb. (50). B C

Clark, H. Walton, Bureau of Fisheries, Dept. Commerce and Labor, Washington, D. C. (52). F

*Clark, Hubert Lyman, Ph. D., Professor of Biology, Olivet College, Olivet, Mich. (50). 1903. F

Clark, James Albert, "The Cumberland," Washington, D. C. (52).

Clark, J. Fred, M. D., Fairfield, Iowa. (50). I K

*Clark, Prof. John E., 34 S. Park Terrace, Long Meadow, Mass. (17).

Clark, John Jesse, Manager, Text Book Dept., International Text Book Co., Scranton, Pa. (50). B D

*Clarke, John Mason, Ph. D., Asst. State Geologist and Palæontologist, State Hall, Albany, N. Y. (45). 1897. E

*Clark, John S., 110 Boylston St., Boston, Mass. (31). 1901. B C I

*Clark, Judson F., 164 Davenport Road, Toronto, Canada. (52). 1905. I

Clark, Oliver Durfee, 590 Halsey St., Brooklyn, N. Y. (41). E F

*Clarke, Prof. Samuel Fessenden, Williams College, Williamstown, Mass. (50). 1901. F

Clark, Thomas H., 34 Lancaster St., Worcester, Mass. (40).

Clark, W. A., Ph. D., President State Normal School, Peru, Neb. (52).

Clark, Wm. Brewster, M. D., 50 E. 31st St., New York, N. Y. (33). C F

*Clark, Wm. Bullock, Ph. D., Johns Hopkins University, Baltimore, Md. (37). 1891. E

Claudy, C. H., Managing Editor The American Inventor, 1302 F St., N.W., Washington, D. C. (52). A B C

Claxton, P. P., Univ. of Tennessee, Knoxville, Tenn. (52).

Clay, Albert T., 415 So. 44th St., Philadelphia, Pa. (54).

*Claypole, Edith J., Ph. D., 50 South Grand Ave., Pasadena, Cal. (46). 1899. F

Cleaver, Albert N., South Bethlehem, Pa. (50). D

*Clements, Frederic Edward, Ph. D., Associate Professor of Botany, Univ. of Nebraska, Lincoln, Neb. (52). 1905. G

Clements, George E., M. D., Crawfordsville, Ind. (52). K

Clements, Joseph, M. D., Nutley, N. J. (52). K

*Clements, J. Morgan, Economic Geologist and Mining Engineer, 11 William St., New York, N. Y. (51). 1903. E

Clerc, Frank L., Hotel Shirley, Denver, Colo. (50). C D

Clifford, Harry Ellsworth, Mass. Inst. Technology, Boston, Mass. (54).

Clifton, Richard S, Assistant Secretary A. A. A. S., Washington, D. C. (49). F

Cline, Isaac M., M. D., U. S. Weather Bureau, New Orleans, La. (50). **K**

Clinton, George P., Botanist, Conn. Agrl. Ex. Sta., New Haven, Conn. (54). **G**

*Cloud, John W., 974 Rookery, Chicago, Ill. (28). 1886. **A B D**

Clough, Albert L., Box 114, Manchester, N. H. (45). **B**

Clough, Homer W., Weather Bureau, Washington, D. C. (54). **A B**

Coates, Charles E., Ph. D., Louisiana State Univ., Baton Rouge, La. (46). **C**

*Cobb, Prof. Collier, University of North Carolina, Chapel Hill, N. C. (49). 1905. **E**

Cobey, W. W., U. S. Dept. Agriculture, Washington, D. C. (54). **G**

Coca, Arthur F., M. D., Wayne, Pa. (54). **K**

*Cochran, C. B., 514 South High St., West Chester, Pa. (43). 1896. **C**

*Cockerell, T. D. A., University of Colorado, Boulder, Colo. (50). 1901. **F**

Coe, George Albert, Professor of Philosophy, Northwestern University, Evanston, Illinois. (54). **I**

COE, HENRY W., M. D., "The Marquam," Portland, Oregon. (32). **F H**

Coe, Thomas Upham, M. D., Bangor, Maine. (51). **K**

Coffeen, Hon. H. A., Sheridan, Wyoming. (51).

Coffin, C. A., 44 Broad St., New York, N. Y. (50).

Coffin, Fletcher B., Newton, Mass. (53). **C**

*Coffin, Rev. Selden J., Ph. D., Lafayette College, Easton, Pa. (22). 1874. **A I**

*Coghill, George Ellett, Ph. D., Professor of Biology, Pacific Univ., Forest Grove, Oregon. (52). 1903. **F G**

*Cogswell, Wm. B., Syracuse, N. Y. (33). 1891. **D**

Cohen, Mendes, Civil Engineer, 825 N. Charles St., Baltimore, Md. (50). **D**

*Cohen, Solomon Solis, M. D., 1525 Walnut St., Philadelphia, Pa. (50). 1903. **F K**

Coit, Rev. Dr. Joseph Howland, Rector Saint Paul's School, Concord, N. H. (50).

Coit, Judson B., Professor of Mathematics and Astronomy, Boston University, Boston, Mass. (54). **A**

*Coit, J. Milner, Ph. D., Vice-Rector Saint Paul's School, Concord, N. H. (33). 1903. **B C E**

*Coker, Wm. Chambers, Ph. D., Associate Professor of Botany, Univ. of North Carolina, Chapel Hill, N. C. (52). 1905. **G**

*COLBURN, RICHARD T., Elizabeth, N. J. (31). 1894. **F H I**

Colby, Edward A., care Baker Platinum Works, Newark, N. J. (49).

Cole, Aaron Hodgman, 5715 Monroe Ave., Hyde Park, Chicago, Ill. (54). **F G**

*Cole, Prof. Alfred D., Ohio State Univ., Columbus, Ohio. (39). 1891. B C

Cole, George Watson, Riverside, Conn. (52).

Cole, Leon Jacob, 41 Wendell St., Cambridge, Mass. (52). F

Cole, W. F., M. D., Waco, Texas. (51). K

Coleman, Clyde B., 512 S. Matthews St., Urbana, Ill. (54).

Coleman, Walter, Prof. of Natural History, Sam Houston Normal Institute, Huntsville, Texas. (51). K

Colie, Edw. M., East Orange, N. J. (30). E I

Collett, Samuel Williamson, Principal of High School, Urbana, Ohio. (50). G

*Collier, Arthur James, U. S. Geological Survey, Washington, D. C. (52). 1905. E

Collier, Price, Tuxedo Park, N. Y. (50).

*Collin, Prof. Alonzo, Cornell College, Mount Vernon, Iowa. (21). 1891. B C

Collin, Rev. Henry P., Pastor First Presbyterian Church, 58 Division St., Coldwater, Mich. (37). H

*Collingwood, Francis, Elizabeth, N. J. (36). 1888. D

Collins, Guy N., U. S. Department of Agriculture, Washington, D. C. (51). G

Collins, T. Shields, M. D., Globe, Arizona. (51). K

Colton, Geo. H., Professor of Natural Science, Hiram College, Hiram, Ohio. (51). B E

Colton, H. S., 3409 Powellton Ave., Philadelphia, Pa. (54). E

*Colvin, Verplanck, Supt. N. Y. State Adirondack Survey, Albany, N. Y. (28). 1880. E

Compton, Edith L., Instructor in Dept. Biol. Washington High Schools, 1121 Roanoke St., N.W., Washington, D. C. (54). G

Comstock, Brig.-Genl. C. B., 124 East 27th St., New York, N. Y. (54).

*Comstock, Prof. Charles Worthington, Civil and Mining Engineer, Boston Bldg., Denver, Colo. (47). 1901. A B

Comstock, Daniel F., Asst. in Physics Mass. Inst. Technology, Boston, Mass. (52). B

*Comstock, Prof. Geo. C., Washburn Observatory, University of Wisconsin, Madison, Wis. (34). 1887. A

Comstock, John Henry, Professor of Entomology, Cornell University, Ithaca, N. Y. (54). F

*COMSTOCK, PROF. THEO. B., Mining and Metallurgical Engineer, 534 Stinson Bldg., Los Angeles, Cal. (24). 1877. B D E

Comstock, Dr. T. Griswold, 3401 Washington Ave., St. Louis, Mo. (29). F H

*Conant, Charles A., Treasurer Morton Trust Co., 38 Nassau St., New York, N. Y. (52). 1903. I

Conant, Miss E. Ida, 42 W. 48th St., New York, N. Y. (33). **F H I**

*Conant, Prof. Levi L., Polytechnic Institute, Worcester, Mass. (39). 1892. **A**

Conarroe, Thomas H., M. D., 1807 Wallace St., Philadelphia, Pa. (50). **F K**

*Conklin, Edwin Grant, Professor of Biology, University of Pennsylvania, Philadelphia, Pa. (50). 1901. **F**

Connaway, John W., Professor Veterinary Science, Missouri State Univ., Columbia, Mo. (52). **F**

Conner, Phineas Sanborn, M. D., 215 W. 9th St., Cincinnati, O. (54). **K**

Connor, Leartus, M. D., President of Michigan State Medical Society, 103 Cass St., Detroit, Mich. (51). **K**

Conradson, Pontus H., Chief Chemist, Galena-Signal Oil Co., Franklin, Pa. (51). **B C D**

Converse, Henry Augustus, Instructor in Math. Balto. Polytechnic Inst., 2017 N. Calvert St., Baltimore, Md. (54). **A**

CONVERSE, JOHN H., 500 N. Broad St., Philadelphia, Pa. (54). **D**

Converse, Vernon G., care of Ontario Power Co., Niagara Falls, Canada. (50). **D**

Cook, Dr. Charles D., 136 Clinton St., Brooklyn, N. Y. (25).

Cooke, George Willis, 49 Park Ave., Wakefield Park, Wakefield, Mass. (47). **H I**

Cooke, Harte, Mechanical Engineer, 92 East Genessee St., Auburn, N. Y. (53). **D**

Cook, James B., Ph. D., Randolph Building, Memphis, Tenn. (50).

*Cook, Melville T., Santiago de las Vegas, Cuba. (45). 1902. **G**

*Cook, Orator F., U. S. Dept. of Agriculture, Washington, D. C. (40). 1892. **G**

*Cook, Samuel R., Case School, Cleveland, Ohio. (50). 1903. **B C**

*Cooley, Grace E., Ph. D., Wellesley College, Wellesley, Mass. (47). 1900. **G I**

*Cooley, Prof. LeRoy C., Vassar College, Poughkeepsie, N. Y. (19). 1880. **B C**

*Cooley, Prof. Mortimer E., University of Michigan, Ann Arbor, Mich. (33). 1885. **D**

*Cooley, Robert A., Zoologist and Entomologist, Montana Agr'l College and Experiment Station, Bozeman, Montana. (50). 1903. **F**

Cooper, Hon. Edward, 12 Washington Square, N., New York, N. Y. (49).

Cooper, Hermon Charles, Ph. D., Syracuse Univ., Syracuse, N. Y. (51). **C**

Cooper, James Campbell, Room 5, Veale Block, Topeka, Kansas. (50). **C E**

*Copeland, Edwin Bingham, Bureau of Government Laboratories, Manila, P. I. (45). 1901. G

*Coplin, W. M. L., M. D., Director of Laboratories, Jefferson Medical College Hospital, Philadelphia, Pa. (51). 1903. K

*Coquillett, Daniel William, U. S. National Museum, Washington, D. C. (43). 1902. F

*Corbett, L. C., U. S. Dept. Agriculture, Washington, D. C. (48). 1901. G

Cornelison, Robert W., Sc. D., Manufacturing Chemist, Bloomfield, N. J. (51). C

Cornish, George A., Lindsay, Ont., Canada. (52). F

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Corwin, Clifford Egbert, Teacher of Science, Marietta High School, Marietta, Ohio. (50). C

Coudra, G. E., Ph. D., University of Nebr., Lincoln, Nebr. (54). E

*Coulter, Prof. John M., University of Chicago, Chicago, Ill. (32). 1884. G

*Coulter, Samuel Monds, Ph. D., The Shaw School of Botany, St. Louis, Mo. (52). 1905. G

Councilman, Wm. Thomas, Prof. of Pathology, Harvard Medical School, Boston, Mass. (54). K

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Coutant, Richard Bonnet, M. D., Tarrytown, N. Y. (51). K

Covert, Rev. William Ross, McMechen, West Virginia. (53).

*Coville, Frederick V., U. S. Dept. Agriculture, Washington, D. C. (35). 1890. G

Cowart, Fletcher Jackson, Prof. Natural Science, State Normal College, Troy, Ala. (53). F

*Cowles, Alfred H., 361 The Arcade, Cleveland, Ohio. (37). 1897. B C

*Cowles, Edward, M. D., 419 Boylston St., Boston, Mass. (51). 1903. K

Cowles, H. C., Instructor in Botany Univ. of Chicago, Chicago, Ill. (54). G

*Cowles, Miss Louise F., Mt. Holyoke College, South Hadley, Mass. (47). 1905. E

Cox, A. Beekman, Civil Engineer, Cherry Valley, N. Y. (50). D

*Cox, Charles F., Grand Central Depot, New York, N. Y. (43). 1900. F G

Cox, Edmund Otis, C. E., 167 East 116th St., New York, N. Y. (51). D

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Cox, Ulysses O., 433 Washington Ave., Terre Haute, Ind. (50). F

Coxe, Eckley B., Jr., U. S. Weather Bureau Observer, Drifton, Pa. (51).

Coyle, Rev. John S., S. J., St. Joseph's College, 17th and Stiles Sts., Philadelphia, Pa. (48). **B**

*Crafts, James Mason, Mass. Inst. Technology, Boston, Mass. (47). 1898. **C**

*Cragin, Francis Whittemore, Ph. D., 1715 Wood Ave., Colorado Springs, Colo. (29). 1890. **E F H**

Craig, Alexander Righter, M. D., 232 Cherry Street, Columbia, Pa. (51). **K**

Craig, John, College of Agriculture, Cornell University, Ithaca, N. Y. (41). **G**

Craig, Moses, Agricultural College P. O., Mich. (53). **G**

Craig, Wallace, Coshocton, Ohio. (50). **F**

Craighead, E. B., President Tulane University, New Orleans, La. (54).

Cram, Roys Jones, 26 Hancock Ave., West, Detroit, Mich. (51).

Cramer, Gustave, Pres. G. Cramer Dry Plate Co., St. Louis, Mo. (53). **B C**

Cramp, W. M., 1227 N. Broad St., Philadelphia, Pa. (54). **D**

*Crampton, Chas. A., M. D., Office of Internal Revenue Commissioner, U. S. Treasury Dept., Washington, D. C. (36). 1887. **C**

Crampton, C. Ward, M. D., 160 West 119th St., New York, N. Y. (53). **K**

*Crampton, Henry E., Adjunct Professor of Zoology, Barnard College, Columbia University, New York, N. Y. (51). 1903. **F**

*Crandall, Charles S., 1104 W. Oregon St., Urbana, Ill. (40). 1894.

Crandall, Francis Asbury, Librarian of Public Documents, 2219 15th St., N.W., Washington, D. C. (50). **I**

Crane, William I., Superintendent City Schools, Marshalltown, Iowa. (54).

Cranston, Robert E., E. M., 36 Physicians Building, Sacramento, Cal. (50). **D E**

Cratty, R. I., Armstrong, Iowa. (52). **G**

Crawford, David Francis, Genl. Supt. Motive Power, Penna. Lines West of Pittsburg, Union Station, Pittsburg, Pa. (50). **D**

Crawford, John, 101 Penna. Ave., N.W., Washington, D. C. (40). **E H**

*Crawford, Morris B., Middletown, Conn. (30). 1889. **B**

*Crawley, Edwin S., Ph. D., University of Pennsylvania, Philadelphia, Pa. (45). 1900. **A**

Crawley, Howard, Wyncote, Pa. (51). **F**

Crawley, Joseph Sanford, Wyncote, Pa. (54).

Crehore, Albert Cushing, 48 Lincoln Terrace, Yonkers, N. Y. (50). **D E**

Creighton, J. E., Cornell Univ., Ithaca, N. Y. (54).

*Crew, Henry, Professor of Physics, Northwestern University, Evanston, Ill. (52). 1903. **B**

*Crile, George W., M. D., 169 Kensington St., Cleveland, Ohio. (51). 1903. **K**

Crockard, Frank Hearne, E. M., C. E., Asst. Mgr. Riverside Dept. National Tube Co., Lock Box 34, Wheeling, W. Va. (50). **D**

*Crocker, Francis B., Professor of Electrical Engineering, Columbia University, New York, N. Y. (50). 1901. **B D**

*Crockett, Prof. Charles W., Rensselaer Polytechnic Institute, Troy, N. Y. (39). 1894. **A D**

*Crook, Alja Robinson, Ph. D., Professor of Mineralogy and Economic Geology, Northwestern University, Evanston, Ill. (47). 1902. **E**

Crosby, Oscar Terry, Cosmos Club, Washington, D. C. (52). **C E I**

Crosby, Wm. Edward, 1603 Amsterdam Ave., New York, N.Y. (52).

*Crosby, Prof. W. O., Mass. Institute Technology, Boston, Mass. (47). 1900. **E**

*Cross, Prof. Charles R., Mass. Inst. Technology, Boston, Mass. (29). 1880. **B**

Cross, Whitman, U. S. Geological Survey, Washington, D. C. (54). **E**

Crouse, Hugh Woodward, M. D., Victoria, Texas. (50). **F K**

Crowell, A. F., Woods Holl, Mass. (30). **C**

*Crowell, John Franklin, Intercontinental Correspondence Univ., 1102 14th St., N.W., Washington, D. C. (50). 1901. **I**

Crowley, Chas. F., 3315 Burt St., Omaha, Neb. (53). **C**

Croxton, Fred. C., U. S. Dept. Commerce and Labor, Washington, D. C. (54). **I**

*Crozier, William, Brigadier-General and Chief of Ordnance, U. S. A., War Department, Washington, D. C. (50). 1903. **D**

Cruikshank, Barton, D. Sc., 1813 West Genesee St., Syracuse, N. Y. (53). **D**

Crump, Col. M. H., Bowling Green, Ky. (29). **E**

Crunden, Frederick Morgan, Librarian Public Library, 3635 Laclede Ave., St. Louis, Mo. (52). **I**

*Culin, Stewart, Brooklyn Institute of Arts and Sciences, Brooklyn, N. Y. (33). 1890. **H**

Cullen, Thomas S., M. D., 3 West Preston St., Baltimore, Md. (54). **K**

Culver, Garry Eugene, 1103 Main St., Stevens Point, Wis. (54). **C E**

*Cumings, Edgar R., Asst. Professor of Geology, Indiana University, Bloomington, Ind. (48). 1901. **E**

*Cummings, Miss Clara E., Wellesley College, Wellesley, Mass. (47). 1899. **G**

Cummins, George Wyckoff, M. D., Belvidere, N. J. (50). **G K**

Cunningham, Francis A., 1613 Wallace St., Philadelphia, Pa. (33). **B D E**

*Cunningham, Prof. Susan J., Swarthmore College, Swarthmore, Pa. (38). 1901. A
Curran, Ulysses T., Probate Judge, Erie Co., Sandusky, Ohio. (52). I
Currie, C. A., M. D., P. O. Box 1606, Philadelphia, Pa. (48). F
*Curtis, Carlton C., Columbia University, New York, N. Y. (51). 1903. G
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Curtis, Mattoon M., Prof. of Philosophy, Western Reserve University, Cleveland, Ohio. (50). H I
Curtiss, C. F., Dean and Director, Iowa State College, Ames, Ia. (54). G
*Curtiss, Richard Sydney, Chemical Laboratory Univ. of Illinois, Urbana, Ill. (52). 1903. C
*Curtis, William E., Post Building, Washington, D. C. (40). 1903. H I
*Curtis, Winterton C., Ph. D., Asst. Prof. of Zoölogy, University of Missouri, Columbia, Mo. (53). 1905. F
Cushing, Harvey, M. D., 3 West Franklin St., Baltimore, Md. (52). K
*Cushing, Henry Platt, Adelbert College, Cleveland, Ohio. (33). 1888. E
*Cushman, Allerton, Ph. D., Bureau of Chemistry, U. S. Dept. Agriculture, Washington, D. C. (50). 1901. C
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Cutter, Ephraim, M. D., 120 Broadway, New York, N. Y. (51). K
Cutter, Irving S., Box 732, Lincoln, Neb. (50). F G
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da Costa Sena, Señor Joaquim Candido, Director School of Mines, Ouro Preto, Brazil. (54). E
Daggette, Alvin S., M. D., 400 South Craig St., Pittsburg, Pa. (50). F K
*Dahlgren, Ulric, Ph. D., Princeton University, Princeton, N. J. (51). 1905. F
Daland, Rev. William Clifton, D. D., President of Milton College, Milton, Wis. (52). I
Dale, J. Y., M. D., P. O. Box 14, Lemont, Pa. (51). K
*Dall, William Healey, Smithsonian Institution, Washington, D. C. (18). 1874. F H

Dalrymple, W. H., Prof. Vet. Science, La. State Univ. and A. & M. College, Baton Rouge, La. (50). **F K**

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*Dana, Edward Salisbury, New Haven, Conn. (23). 1875. **B E**

Daniel, John, Professor of Physics, Vanderbilt Univ., Nashville, Tenn. (50). **B**

*Darton, Nelson H., U. S. Geol. Survey, Washington, D. C. (37). 1893.

Daugherty, Rev. Jerome, S. J., President of Georgetown Univ., Washington, D. C. (52).

Daugherty, Lewis S., Professor of Biology, State Normal School, Kirksville, Mo. (53). **F**

*d'Auria, Luigi, M. E., care Builders Iron Foundry, Providence, R. I. (51). 1903. **A D**

*Davenport, Charles Benedict, Ph. D., Director Station for Experimental Evolution, Cold Spring Harbor, L. I., N. Y. (46). 1898. **F**

Davenport, Eugene, Dean of the College of Agriculture, University of Illinois, Champaign, Ill. (39).

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*Davidson, George, 2221 Washington St., San Francisco, Cal. (29). 1881. **A B D**

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*Davis, Bergen, Columbia University, New York, N. Y. (49). 1905 **B**

*Davis, Bradley Moore, Dept. of Botany, Univ. of Chicago, Chicago, Ill. (45). 1897. **G**

Davis, Charles Gilbert, M. D., 31 Washington St., Chicago, Ill. (51). **K**

*Davis, C. H., Commander U. S. N., Navy Dept., Washington, D. C. (40). 1896.

Davis, Edward E., 47 W. Main St., Norwich, N. Y. (50).

Davis, George S., P. O. Box 724, Detroit, Mich. (50).

Davis, Maj.-Gen. Geo. W., U. S. A., Isthmian Canal Comm., War Dept., Washington, D. C. (54). **D**

*Davis, Herman S., Ph. D., Director of International Latitude Station, Gaithersburg, Md. (50). 1901. **A**

*Davis, J. J., M. D., 1119 College Ave., Racine, Wis. (31). 1899. **F G**

Davis, Kary Cadmus, Ph. D., Menomonee, Wis. (50). **G**

Davis, Nathaniel French, Prof. of Pure Mathematics, Brown University, Providence, R. I. (54). **A**

Davis, N. S., Jr., 291 Huron St., Chicago, Ill. (50). **F G**

*Davis, Wm. Harper, Lehigh University, South Bethlehem, Pa. (50). 1903. **H I**

*Davis, Prof. W. M., 17 Francis Ave., Cambridge, Mass. (33). 1885. **B E**

*Davison, Alvin, Ph. D., Lafayette College, Easton, Pa. (49). 1905. **F**

Davison, John M., 340 Oxford St., Rochester, N. Y. (38). **C**

*DAVY, J. BURTT, State Agrostologist and Botanist, Department of Agriculture, Pretoria, Transvaal. (51). 1903. **G**

*Dawson, Percy Millard, M. D., Instructor in Physiology, Johns Hopkins Medical School, Baltimore, Md. (50). 1903. **K**

Dawson, William Bell, D. Sc., Marine Department, Ottawa, Canada. (54). **D**

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Dean, Arthur Lyman, Ph. D., Yale University, New Haven, Conn. (53). **F**

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Dearborn, George Van Ness, Ph. D., Professor of Physiology, Tufts Medical and Dental Schools, Boston, Mass. (52). **K**

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Delafield, Maturin L., Jr., Fieldston, Riverdale, New York, N. Y. (43). **G**

DE LANDERO, CARLOS F., Asst. Director Pachuca and Real del Monte Mining Co., Pachuca, Mexico. (36). **B C**

Delano, Frederic A., Supt. of Motive Power, C. B. and Q. Railroad, 209 Adams St., Chicago, Ill. (50). **D**

Delany, Patrick Bernard, E. E., Inventor, South Orange, N. J. (50). D

de Lisle, Justin, M. D., 500 Fifth Ave., New York, N. Y. (54). K

*Dellenbaugh, Frederick S., Century Club, 7 West 43d St., New York, N. Y. (51). 1905. H

Demming, Henry Clay, Geologist and Mineralogist, Pa. State Bd. of Agriculture, Harrisburg, Pa. (54). E

Dempster, A., 5721 Stanton Ave., Pittsburg, Pa. (50). D

Dennett, William S., 8 East 49th St., New York, N. Y. (52). A K

*Dennis, David Worth, Professor of Biology, Earlham College. Richmond, Ind. (50). 1901. F

*Dennis, Louis Munroe, Cornell University, Ithaca, N. Y. (43), 1895. C

Densmore, Emmet, 11th Ave. and 84th St., Brooklyn, N. Y. (54). F K

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Derby, George McClellan, Major, Corps of Engineers, U. S. A., U. S. Engineers Office, St. Paul, Minn. (50). D

*Derby, Orville A., Commissao Geologica, Sao Paulo, Brazil, South America. (39). 1890. E

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Detweiler, Andrew J., M. D., State Board of Health, Columbia, Mo (53). K

Devereux, W. B., 99 John St., New York, N. Y. (50).

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*Dexter, Edwin Grant, Ph. D., Professor of Education and Psychology, University of Illinois, Urbana, Ill. (52). 1905. K

Dickerson, E. N., 141 Broadway, New York, N. Y. (49).

Dickie, George William, San Mateo, Calif. (54). D

Dickinson, Gordon K., M. D., 278 Montgomery St., Jersey City, N. J. (51). K

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Dietz, William G., M. D., 21 N. Vine St., Hazleton, Pa. (54). K

Dike, Archie Clarence. Bristol, Vermont. (54).

*Diller, J. S., U. S. Geological Survey, Washington, D. C. (52). 1903. E

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Dinkey, Alva C., General Supt. Homestead Steel Works, Munhall, Pa. (50). D

Disbrow, William S., M. D., 151 Orchard St., Newark, N. J. (51). K
Dixon, Brandt B., President of Newcomb College, New Orleans, La. (52). K
*Dixon, Roland B., Peabody Museum, Cambridge, Mass. (46). 1901. H
Dixon, Samuel Gibson, M. D., Acad. Nat. Sciences, 1900 Race St., Philadelphia, Pa. (50). F K
Dixson, Prof. Zella Allen, Librarian University of Chicago Chicago, Ill. (52). I
*Dock, George, M. D., Professor of Medicine, University of Michigan, Ann Arbor, Mich. (51). 1903. K
*Dodge, Charles Richards, 1336 Vermont Ave., N.W., Washington, D. C. (22). 1874.
*Dodge, Charles Wright, Univ. of Rochester, Rochester, N. Y. (39). 1898. F
Dodge, D. Stuart, 6 East 49th St., New York, N. Y. (49).
Dodge, Philip T., Tribune Building, New York, N. Y. (44). B D
*Dodge, Richard E., Teachers' College, Columbia Univ., New York, N. Y. (49). 1901. E I
Dodman, Alfred C., Jr., 235 W. 108th St., New York, N. Y. (50).
Dodson, John Milton, Prof. of Medicine and Dean of Students, Rush Medical College, 1109 Venetian Building, Chicago, Ill. (54). K
Dodson, W. R., Director and Botanist of La. Experiment Station, Baton Rouge, La. (54). G
Doherty, Henry L., 40 Wall St., New York, N. Y. (48). B C D
*Dolbear, Prof. A. Emerson, Tufts College, Mass. (20). 1880. B
Dole, Rev. Charles Fletcher, Jamaica Plain, Mass. (50). I
Donaldson, Henry Herbert, Professor of Neurology, University of Chicago, Chicago, Ill. (54). K
Donovan, Cornelius, Assistant Engineer, U. S. Engineer Office, Custom House, New Orleans, La. (51). D
*Doolittle, Prof. C. L., Upper Darby, Pa. (25). 1885. A
Doran, Edwin W., 603 Daniel St., Champaign, Ill. (54). F
*Dorsey, George A., Ph. D., Field Columbian Museum, Chicago, Ill. (39). 1892. H
Dorsey, Herbert Grove, Granville, Ohio. (51). B
*Dorsey, N. Ernest, Ph. D., Annapolis Junction, Md. (46). 1898. B
Doty, Paul, 230 Woodward Ave., Detroit, Mich. (43). D
Doubt, Thomas Eaton, Ph. D., 651 East 57th St., Chicago, Ill. (48). B
Doughty, Mrs. Alla, Milford, Pa. (49).
DOUGHTY, JOHN W., 165 Johnston St., Newburgh, N. Y. (19). E
Douglas, Edward Morehouse, U. S. Geological Survey, Washington. D. C. (54). E
Douglas, Mrs. George William, Tuxedo Park, N. Y. (49).

*Douglas, James, 99 John St., New York, N. Y. (49). 1905. E
Douglas, Orlando B., 20 Pleasant St., Concord, N. H. (49).
*Dow, Allan Wade, 1724 Q St., N.W., Washington, D.C. (52). 1905. C D
Dow, Herbert H., Midland, Mich. (47). C
Dowell, Philip, Ph. D., 12 Bond St., Port Richmond, N. Y. (50). F
Downing, Elliott Rowland, Ph. D., Professor of Biology, Northern State Normal School, Marquette, Mich. (51). F
Downs, Edgar Selah, Ph. D., 44 West St., Bristol, Conn. (50). B
Downs, Norton, M. D., 215 West Walnut Lane, Germantown, Philadelphia, Pa. (52). K
Dozier, Melville, Professor of Mathematics and Physical Sciences, State Normal School, Los Angeles, Cal. (53). A B
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Draper, Mrs. Henry, 271 Madison Ave., New York, N. Y. (49).
Drayer, Howard C., Yeatman High School, St. Louis, Mo. (51).
Drescher, Willibald A. E., P. O. Drawer 1033, Rochester, N. Y. (41). F
Drew, Gilman A., Prof. of Zoölogy, Univ. of Maine, Orono, Me. (54). F
Dreyfus, Dr. William, 162 East 95th St., New York, N. Y. (52). C
*DROPPERS, GARRETT, President of the State University, Vermillion, S. Dak. (50). 1901. I
Drummond, Isaac Wyman, Ph. D., 436 W. 22d St., New York, N. Y. (36).
*Dryer, Charles Redway, Professor of Geography, Indiana State Normal School, Terre Haute, Ind. (50). 1903. E
Duane, Alexander, M. D., 49 East 30th St., New York, N. Y. (54). K
Duane, Russell, 911 Pine St., Philadelphia, Pa. (50). I
*Duane, William, Ph. D., Professor of Physics, State University. Boulder, Colo. (50). 1901. B
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Du Bois, Howard Weidner, 4526 Regent St., Philadelphia, Pa, (47). A
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*Du Bois, W. E. Burghardt, Professor of Economics and History, Atlanta University, Atlanta, Ga. (50). 1905. I
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*Dudley, Charles B., Drawer 156, Altoona, Pa. (23). 1882. B C D
Dudley, S. W., Box 512 Kelly Ave., Wilkinsburg, Pa. (50). A D
*DUDLEY, WM. L., Vanderbilt University, Nashville, Tenn. (28). 1881. C

*Dudley, Prof. Wm. R., Dept. of Systematic Botany, Stanford University, Cal. (29). 1883. G

*Duerden, J. E., Ph. D., Professor of Biology, University of Michigan, Ann Arbor, Mich. (52). 1905. F

*Duggar, Benjamin Minge, Professor of Botany, Univ. of Missouri, Columbia, Mo. (45). 1900. G

Duke, Frank Williamson, Professor of Mathematics, Hollins Institute, Hollins, Va. (50). A

Dulles, Charles W., M. D., 4101 Walnut St., Philadelphia, Pa. (51). K

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Duncan, Fred. N., Professor of Chemistry, Emory College, Oxford, Ga. (50). C

*Duncan, George Martin, Professor of Philosophy, Yale University, New Haven, Conn. (50). 1902. H

Duncanson, Henry Bruce, Professor of Biology, State Normal School, Peru, Neb. (50). F

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Dunham, Henry Bristol, M. D., State Sanatorium, Rutland, Mass. (51). K

Dunham, William Russell, 55 Court St., Keene, N. H. (54). K

Dunlevy, Robert Baldwin, Southwest Kansas College, Winfield, Kansas. (50). C E

Dunn, Gano Sillick, Vice-President and Chief Engineer, Crocker-Wheeler Company, Ampere, N. J. (50). D

Dunn, Ira J., M. D., 810 Peach St., Erie, Pa. (51). K

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*Dunstan, A. St. C., Professor of Electrical Engineering, Polytechnic Institute, Auburn, Ala. (50). 1901. B D

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*Duvel, Joseph W. T., U. S. Dept. of Agriculture, Washington, D.C. (48). 1905. G

Dwight, Jonathan, Jr., M. D., 2 E. 34th St., New York, N. Y. (49).

*Dwight, Prof. William B., Vassar College, Poughkeepsie, N. Y, (30). 1882. E F

*Dyar, Harrison G., Ph. D., U. S. National Museum, Washington. D. C. (43). 1898.

Dyche, Lewis Lindsay, Professor of Systematic Zoology and Taxidermist, University of Kansas, Lawrence, Kans. (51). F

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Earhart, Robert F., Asst. Professor of Physics, Ohio State University, Columbus, Ohio. (53). B

*Earle, F. S., Estacion Central Agronomica, Santiago de las Vegas, Cuba. (39). 1896. G

Earle, Samuel Broadus, Professor of Mechanical Engineering, Clemson College, S. C. (54). D

Earll, Charles Isaac, M. E., 76 William St., New York, N. Y. (52). D

*Eastman, Charles Rochester, Museum Comp. Zoology, Cambridge, Mass. (41). 1896. E F

*Eastman, Prof. J. R., Andover, N. H. (26). 1879. A

Easton, Christopher, 70 Church St., Newport, R. I. (52). I K

*Eastwood, Miss Alice, Curator of Herbarium, California Academy of Sciences, San Francisco, Cal. (50). 1901. G

Eaton, E. Howard, 259 Park Ave., Rochester, N. Y. (52). F

Eaton, George Francis, 80 Sachem St., New Haven, Conn. (54).

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Edwards, Col. Clarence R., U. S. A., Chief of the Bureau of Insular Affairs, War Department, Washington, D. C. (52). I

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Gale, Arthur Sullivan, Asst. Prof. of Mathematics, Univ. of Rochester, Rochester, N. Y. (54). A
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*Gill, Augustus Herman, Mass. Institute Technology, Boston, Mass. (44). 1896. **C**

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Goldthwait, James Walter, Assistant in Geology, Harvard University, Cambridge, Mass. (51). E
Goldthwaite, Miss Nellie Esther, Mount Holyoke College, So. Hadley, Mass. (47). C
*Gomberg, Moses, Sc. D., Chem. Lab. Univ. of Michigan, Ann Arbor, Mich. (51). 1903. C
*Gooch, Frank A., Yale University, New Haven, Conn. (25). 1880. C
*Goodale, Prof. George Lincoln, Botanic Gardens, Cambridge, Mass. (18). 1875. G
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*Goode, John Paul, Asst. Prof. of Geography, University of Chicago, Chicago, Ill. (52). 1905. E H I
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*Goodwin, Harry M., Professor of Physical Chemistry, Mass. Institute Technology, Boston, Mass. (47). 1901. B
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Gordon, Clarence McC., Ph. D., Professor of Physics, Centre College, Danville, Ky. (48). A B C
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Gordon, Reginald, Newburgh, N. Y. (50).
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Hadley, Stephen Marshall, Ph. D., Prof. of Mathematics and Astronomy Penn College, Oskaloosa, Iowa. (54). A
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*Hall, Robert William, Lehigh University, South Bethlehem, Pa. (50). 1905. F

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Hammatt, Clarence Sherman, Vice-President, Florida Electric Co. Jacksonville, Fla. (50). D

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Hart, Rev. Prof. Samuel, Berkeley Divinity School, Middletown, Conn. (22). A

Hartgering, James, Rapid City, S. Dak. (52). C D

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Hartmann-Kempf, Dr. Robert, Frankfort A. M., Germany. (54). B

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Johnson, Herbert Parlin, Grand Ave. and Caroline St., St. Louis, Mo. (54). K

Johnson, Miss Isabel Louise, 467 Mass. Ave., Station A, Boston, Mass. (47). E

Johnson, John Benjamin, 708 East Colorado St., Pasadena, California. (51). F

*Johnson, Otis C., 730 Thayer St., Ann Arbor, Mich. (34). 1886. C

Johnson, Thomas Carskadon, Asst. Horticulturist, West Virginia Agr. Exp. Sta., Morgantown, West Virginia. (51). G

*Johnson, Willis Grant, 52 Lafayette Place, New York, N. Y. (47). 1901. F

Johnson, W. Smythe, Ph. D., Univ. of Arkansas, Fayetteville, Ark. (49). H

Johnston, Geo. Ben., M. D., 407 E. Grace St., Richmond, Va. (51). K

*Johnston, John Black, Professor of Zoology, Univ. of West Va. Morgantown, W. Va. (52). 1903. F

Johnston, Thomas J., 66 Broadway, New York, N. Y. (50). A B D

Johnston, William A., Prince Bay, Borough of Richmond, N. Y. (50). C

Johnstone, Wm. Bard, 22 West 25th St., New York, N. Y. (50). B

*Johonnott, Edwin Sheldon, Ph. D., Associate Professor of Physics, Rose Polytechnic Institute, Terre Haute, Ind. (50). 1903. B

*Jones, Adam Leroy, Ph. D., Tutor in Philosophy, Columbia University, New York, N. Y. (52). 1905. H I

Jones, Arthur Taber, Instructor in Physics, Purdue University, La Fayette, Ind. (53). B

Jones, Clement Ross, Professor Mechanical Engineering, West Virginia University, Morgantown, W. Va. (50). D

Jones, Ernest S., Instructor in Biology, University of Virginia, Charlottesville, Va. (52). F

*Jones, Frederick S., Professor of Physics, University of Minnesota, Minneapolis, Minn. (45). 1901. B

Jones, Grinnell, Harvard University, Cambridge, Mass. (52). C

*Jones, Lewis Ralph, Professor of Botany, University of Vermont, Burlington, Vt. (41). 1894. G

*Jones, Lynds, M. Sc., Instructor in Zoology, Oberlin College, Oberlin, Ohio. (50). 1905. F

*Jones, Prof. Marcus E., Salt Lake City, Utah. (40). 1893. G

Jones, Philip Mills, M. D., 1710A Stockton St., San Francisco, Cal. (50).

Jones, William H., Director Winona Technical Institute, Indianapolis, Ind. (54).

*Jordan, Prof. David Starr, President of Stanford University, Stanford University, Cal. (31). 1883. F

*Jordan, Edwin Oakes, Ph. D., University of Chicago, Chicago, Ill. (50). 1901. K

*Jordan, Whitman H., Director N. Y. Agric. Exper. Station, Geneva, N. Y. (45). 1902. I

Juat, Francis, M. D., Aberdeen, N. C. (50). F K

*Judd, Dr. Charles H., Yale University, New Haven, Conn. (49). 1901. H I

*Julien, Alexis A., Columbia University, New York, N. Y. (24). 1875. C E

Jungblut, Herman C., M. D., Tripoli, Iowa. (52). K

Just, Jno. A., Chemist, Jefferson Ave. and Delano St., Pulaski, N. Y. (50). C

Kaadt, Peter S., M. D., Clinton, Ia. (54). K

Kahl, Paul Hugo Isidor, Carnegie Museum, Pittsburg, Pa. (50). F

*Kahlenberg, Louis, Ph. D., Professor of Physical Chemistry, Univ. of Wisconsin, Madison, Wis. (46). 1898. C

Kahn, Julius, 100 West 80th St., New York, N. Y. (50). C

Kammerer, Jacob Andrae, 87 Jameson Ave., Toronto, Canada. (50). C D

Kane, Elisha Kent, Kushequa, Pa. (54). D

Kann, Myer M., Station B, Pittsburg, Pa. (51).

*Kasner, Edward, Ph. D., Tutor in Mathematics, Barnard College, Columbia University, New York, N. Y. (52). 1903. A

Kasson, Hon. John Adam, 1726 I St., N. W., Washington, D. C. (54). I

Kauffman, William Albert, 73 Hooker Ave., Poughkeepsie, N. Y. (52).

Kay, James I., 426 Diamond St., Pittsburg, Pa. (51). D I

Kean, Mrs. Hamilton Fish, 25 East 37th St., New York, N. Y. (50).

Keane, John J., Rt. Rev., Archbishop of Dubuque, Dubuque, Ia. (51).

Kearfott, W. D., care of Geo. A. Blake Mfg. Co., 95 Liberty St., New York, N. Y. (54). F

*Kearney, Thomas H., U. S. Dept. Agriculture, Washington, D. C. (47). 1902. G

*Keasbey, Lindley Miller, Professor of Economics and Politics, Bryn Mawr College, Bryn Mawr, Pa. (51). 1903. H I

*Keep, Wm. J., Detroit, Mich. (37). 1897.

Keilholtz, Pierre Otis, Consulting Engineer, Continental Trust Building, Baltimore, Md. (50). D

Keim, Edward Tudor, E. E., Supt. Am. Dist. Tel. Co., 1421 Champa St., Denver, Colo. (50). D E F

Keith, John Meiggs, Manager Costa Rica Div. United Fruit Co., San José, Costa Rica, C. A. (54). G

Keith, Prof. Marcia A., Braintree, Mass. (46). B

*Keller, Edward, Ph. D., Box 724, Baltimore, Md. (50). 1903. C D

Keller, Emil E., P. O. Box 452, Pittsburg, Pa. (51).

*Kellerman, William A., Ph. D., Ohio State University, Columbus, Ohio. (41). 1893. G

Kelley, Walter S., Mining Engineer, 1393 Golden Gate Ave., San Francisco, Cal. (50). D

Kellogg, John H., M. D., Battle Creek, Mich. (24). F

*Kellogg, Vernon Lyman, Professor of Entomology, Stanford University, California. (50). 1901. F

Kelly, John F., Ph. D., Consulting Electrical Engineer, 248 W. Housatonic St., Pittsfield, Mass. (50). D

Kelly, William, Mining Engineer, General Manager Penn. Iron Mining Co., Vulcan, Mich. (50). D E

Kelsey, James A., Dunlap, Iowa. (49).

Kemp, George T., Professor of Physiology, University of Illinois, Champaign, Ill. (52). K

*Kemp, James F., School of Mines, Columbia University, New York, N. Y. (36). 1888. E

Kempton, Charles Walter, Mining Engineer, 29 Broadway, New York, N. Y. (54). E

Kendall, Arthur I., 106 Jackson Place, Baltimore, Md. (52).

Kendall, Hugh F., Mining Engineer, Carlson Exploration Co., Hibbing, Minn. (50). E

Kendall, William Converse, Bureau of Fisheries, U. S. Department of Commerce and Labor, Washington, D. C. (52).

*Kendrick, Arthur, Electrical Measuring Instruments, 45 Hunnewell Ave., Newton, Mass. (45). 1897. B

Kennedy, Frank Lowell, Instructor in Lawrence Scientific School, Harvard University, Cambridge, Mass. (50.)

Kennedy, George Golding, M. D., Readville, Mass. (40). F G

KENNEDY, HARRIS, 284 Warren St., Roxbury, Mass. (40). E F

Kennedy, Mary E., Teacher of Botany, Maryville College, Maryville, Tenn. (54). G

*Kennelly, Arthur Edwin, Sc. D., Professor Electrical Engineering, Harvard University, Cambridge, Mass. (50). 1901. B D

Kent, James Martin, Instructor in Steam and Electricity, Manual Training High School, Kansas City, Mo. (50). D E

Kent, Norton Adams, Ph. D., Professor Physics, Wabash College, Crawfordsville, Ind. (50). A

*Kent, William, Professor of Mechanical Engineering, Syracuse University, Syracuse, N. Y. (26). 1881. D I

Kenyon, Oscar Curtis, Teacher of Physics, High School, Syracuse, N. Y. (50). B

Keppel, F. P., Secretary of Columbia University, West 116th St., New York, N. Y. (51).

Keppler, Rudolph, 28 W. 70th St. New York, N. Y. (49).

Kern, Frank Dunn, 140 S. Grant St., Lafayette, Ind. (54). G

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Kern, Josiah Quincy, Ph. D., 1825 F St., N.W., Washington, D. C. (40). I

Kerr, Abram Tucker, Assistant Professor of Anatomy, Cornell University, Ithaca, N. Y. (52). K

Kerr, William Jasper, D. Sc., President of Agricultural College of Utah, Logan, Utah. (52). A

*Kershner, Prof. Jefferson E., Lancaster, Pa. (29). 1883. A B

Kesler, John Louis, Department of Biology, Baylor University, Waco, Texas. (51). F

Kester, Fred. Edward, Ohio State University, Columbus, Ohio. (48). B

Ketchum, Alexander P., 32 Mt. Morris Park, W., New York, N. Y. (49).

*Keyser, Cassius Jackson, Ph. D., Prof. of Mathematics, Columbia University, New York, N. Y. (50). 1901. A

Kilgore, Benjamin Wesley, Director, N. C. Agric. Exper. Station, Raleigh, N. C. (52). C

Kimball, Albert B., M. E., Central High School, Springfield, Mass. (47). B

*Kimball, Arthur Lalanne, Professor of Physics, Amherst College, Amherst, Mass. (50). 1901. B

Kimball, Edwin Boyce, Mining Engineer, Oroville, Cal. (50). D

Kimball, James H., Observer U. S. Weather Bureau, Richmond, Va. (51). A B

Kimball, S. I., Life Saving Service, U. S. Treasury Dept., Washington, D. C. (49). I

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*King, A. F. A., M. D., 1315 Mass. Ave., N.W., Washington, D. C. (29). 1900. F H

*King, Cyrus A., Ph. D., Gresham Court, 101 West 140th St., New York, N. Y. (50). 1903. G

*King, F. H., University of Wisconsin, Madison, Wis. (32). 1892. E F

King, George B., Lawrence, Mass. (47).

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King, Theo. Ingalls, U. S. Naval Observatory, Washington, D. C. (52). A

*Kingsbury, Albert, Professor of Applied Mechanics, Worcester Polytechnic Institute, Worcester, Mass. (43). 1898. **D**

*Kingsbury, Benj. F., Stimson Hall, Cornell University, Ithaca, N. Y. (45). 1899. **F**

*Kingsley, J. Sterling, Tufts College, Mass. (52). 1903. **F**

Kinner, Hugo, M. D., 1103 Rutger St., St. Louis, Mo. (21). **F H**

Kinney, Charles Noyes, Professor of Chemistry, Drake University, Des Moines, Iowa. (50). **C**

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Kinraid, Thomas Burton, 38 Spring Park Avenue, Jamaica Plain, Mass. (47).

Kinsler, John H., Dept. of Agriculture, Washington, D. C. (52). **G**

*Kinsley, Carl, Quadrangle Club, Chicago, Ill. (47). 1903. **B**

*Kinyoun, J. J., M. D., Glenolden, Pa. (51). 1903. **K**

Kirby, Gustavus T., 2 Wall St., New York, N. Y. (54). **B D**

Kirk, Edward C., 554 So. Lansdowne Ave., Lansdowne, Pa. (54).

Kirk, Hyland C., 211 6th St., N.E., Washington, D. C. (52). **I**

*Kirkpatrick, E. A., State Normal School, Fitchburg, Mass. (49). 1905. **H I**

Kirkpatrick, Samuel, M. D., Selma, Ala. (51). **K**

*Kirkwood, Joseph E., Instructor in Botany, Syracuse University, Syracuse, N. Y. (51). 1905. **G**

*Kirschmann, A., Ph. D., Toronto University, Toronto, Can. (50). 1901. **H K**

Kittredge, Miss H. A., 56 Prospect St., North Andover, Mass. (37). **F**

Klebs, Arnold C., M. D., 706, 100 State St., Chicago, Ill. (51). **K**

Klepetko, Frank, Consulting Engineer, 307 Battery Park Bldg., New York, N. Y. (50). **D**

Kletzsch, Gustav A., M. D., 453 Cass St., Milwaukee, Wis. (51). **K**

Klie, G. H. Chas., M. D., 5100 N. Broadway, St. Louis, Mo. (39). **C F**

*Klotz, Otto Julius, 437 Albert St., Ottawa, Can. (38). 1889.

Knab, Frederick, U. S. National Museum, Washington, D. C. (53). **F**

Knapp, Alfred A., M. D., Brimfield, Ill. (51). **K**

Knapp, G. N., College of Agriculture, Madison, Wis. (46). **G H**

*Knapp, Hon. Martin A., Chairman of the Interstate Commerce Commission, Washington, D. C. (52). 1903. **I**

Knapp, S. A., President of Rice Assn. of America, Lake Charles, La. (54). **G**

Knauff, Francis Henry, Oak Lane, Philadelphia, Pa. (51). **D**

Knerr, Ellsworth B., Sc. D., Midland College, Atchison, Kas. (51).

*Knight, Prof. Charles M., 129 Union St., Akron, Ohio. (29). 1903. B C

Knight, Wm. H., President So. California Academy of Sciences, 2 Bryson Block, Los Angeles, Cal. (51). A

*Knipp, Charles Tobias, 506 W. Illinois St., Urbana, Ill. (46). 1900. B

*Knower, Henry McElderry, Ph. D., Johns Hopkins Medical School, Baltimore, Md. (52). 1905. F

Knowles, Morris, Resident Engineer, Bureau of Filtration, 1017 Frick Bldg., Pittsburg, Pa. (51). D

Knox, Francis H., Electrical Engineer, 814 Lewis Bldg., Pittsburg, Pa. (50). D

Knox, Geo. Platt, Teacher of Chemistry, High School, 5178A Morgan St., St. Louis, Mo. (53). C

Knox, Henry H., Mining Engineer, 103 East 29th St., New York, N. Y. (50). D

Knox, Wilm, Society for Savings Building, Cleveland, Ohio. (38).

*Kober, Geo. Martin, M. D., 1600 T St., N.W., Washington, D. C. (40). 1896. H

Koch, Waldemar, Ph. D., Assistant Professor of Physiological Chemistry and Pharmacology, University of Missouri, Columbia, Mo. (53). C

*Kofoid, Prof. Charles Atwood, University of California, Berkeley, Cal. (48). 1899. F

Kolbenheyer, Fred'k, M. D., 2006 Lafayette Ave., St. Louis, Mo. (51). K

Koues, Miss Elizabeth L., 282 W. 85th St., New York, N. Y. (41). I

*KRAEMER, PROF. HENRY, 145 N. 10th St., Philadelphia, Pa. (47). 1901. G

Kraus, Edward H., Ph. D., University of Michigan, Ann Arbor, Mich. (50). E

Krause, Otto H., Prospect Ave., Hackensack, N. J. (50).

Krécsy, Prof. Béla, VI Bulyovsxky u. 22, Budapest, Hungary. (41). C

*Kremers, Prof. Edward, University of Wisconsin, Madison, Wis. (47). 1901. C

Kress, Palmer J., M. D., 24 South Seventh St., Allentown, Pa. (51). K

Kretz, Walter C., Engineer J. A. Roebling's Sons Co., Trenton, N. J. (54). A D

Kribs, Herbert Guy, 300 Highland Ave., Chestnut Hill, Philadelphia, Pa. (53). F

*Kroeber, A. L., Ph. D., Affiliated Colleges, San Francisco, Cal. (47). 1901. H

Kuh, Sydney, M. D., Columbus Memorial Bldg., 103 State St., Chicago, Ill. (54). H K

Kuhne, F. W., 723 Court St., Fort Wayne, Ind. (38). A F

Kummer, Frederic Arnold, Civil Engineer, President, United States Wood Preserving Co., 29 Broadway, New York, N. Y. (51). D

Kunhardt, Wheaton B., 1 Broadway, New York, N. Y. (49).

Kuntze, Dr. Otto, Villa Girola, San Remo, Italy. (49).

*Kunz, G. F., care of Messrs. Tiffany & Co., Union Square, New York, N. Y. (29). 1883. C E H

Kunz, George H., Mohegan, N. Y. (52).

*Lachman, Arthur, Ph. D., Second and Bryant Sts., San Francisco, Cal. (50). 1901. C D

*Ladd, Prof. E. F., Agricultural College, Fargo, No. Dakota. (36). 1889. C

Ladd, George Tallman, care Bass Foundry and Machine Co., Fort Wayne, Ind. (51).

Ladd, George Trumbull, 204 Prospect St., New Haven, Conn. (54). K

Ladd, James B., Real Estate Trust Bldg., Philadelphia, Pa. (54). D

La Fetra, Linnaeus Edford, M. D., 58 West 58th St., New York, N. Y. (50). F H K

*Laflamme, Prof. J. C. K., Laval University, Quebec, Can. (29). 1887. B E

*La Flesche, Francis, 214 First St., S.E., Washington, D. C. (33). 1885. H

*Lamb, Daniel S., M. D., 800 10th St., N.W., Washington, D. C. (40). 1894. H

*Lambert, Preston A., 215 S. Center St., Bethlehem, Pa. (41). 1896. A

Lampard, Henry, 102 Shuter St., Montreal, Can. (40). C D E

Lanahan, Henry, Professor Physics and Civil Engineering, Maryland Agricultural College, College Park, Md. (52). B D

Lancaster, Walter B., M. D., 101 Newbury St., Boston, Mass. (51). K

*Land, William Jesse Goad, Dept. Botany, Univ. of Chicago, Chicago, Ill. (52). 1903. G

Landacre, Francis L., Associate Professor of Zoology and Entomology, Ohio State University, Columbus, Ohio. (53). F

*Landes, Henry, State Geologist, Seattle, Wash. (51). 1903. E

Landis, Edward Horace, Instructor in Physics and Chemistry, Central High School, Philadelphia, Pa. (52). A B C

Landis, W. W., Dickinson College, Carlisle, Pa. (50).

Landon, Francis G., Staatsburg-on-Hudson, N. Y. (50).

*Landreth, Olin H., Professor of Engineering, Union University, Schenectady, N. Y. (28). 1883. D

*Lane, Alfred C., State Geologist, Lansing, Mich. (50). 1902. **E**

Lane, Horace Manley, M. D., Caixa 14 S. Paulo, Brazil, South America. (46).

Lang, Prof. Henry R., Yale University, New Haven, Conn. (41). **H**

Lange, J. D., 47 West 42d St., New York, N. Y. (49).

Lange, Philip A., Supt. Westinghouse Elec. and Mfg. Co., Pittsburg, Pa. (50). **D**

*Langenbeck, Karl, 1434 Q St., N.W., Washington, D.C. (39). 1896. **C**

*Langley, Prof. S. P., Smithsonian Institution, Washington, D. C. (18). 1874. **A B**

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*Langsdorf, Alexander Suss, Assistant Professor of Electrical Engineering, Washington University, St. Louis, Mo. (50). 1903. **B D**

Lansing, John Ernest, Instructor in Natural Sciences, Phillips Academy, Andover, Mass. (52). **B C E**

Lantz, Miss Willie A., Teacher of Science, Woman's College, Frederick, Md. (54). **F G**

*Lanza, Prof. Gaetano, Mass. Institute Technology, Boston, Mass. (29). 1882. **A B D**

Laramy, Robert Edward, Teacher in Moravian School, 27 North New St., Bethlehem, Pa. (51). **E**

Lare, H. S. P., M. D., 3452 Park Ave., St. Louis, Mo. (49).

*Larkin, Edgar L., Director of Lowe Observatory, Echo Mountain, Cal. (51). 1903. **A**

Larkin, John Charles, M. D., Hillsboro, Ohio. (54). **K**

Larrabee, Austin P., Teacher of Biology, Salt Lake High School, Salt Lake City, Utah. (54). **F**

Latham, Vida A., M. D., 808 Morse Ave., Rogers Park, Chicago, Ill. (53). **C F K**

Lathbury, B. Brentnall, C. E., Consulting Chemist, 1619 Filbert St., Philadelphia, Pa. (51). **D.**

Latimer, Thos. S., M. D., 211 W. Monument St., Baltimore, Md. (50). **F H K**

Latta, James Edward, Teacher of Physics, Univ. of North Carolina, Chapel Hill, N. C. (54). **B**

Latta, John Milton, M. D., 301 Winne Building, Wichita, Kans. (54). **K**

*Lattimore, Prof. S. A., University of Rochester, Rochester, N. Y. (15). 1874. **C**

Lauder, George, 7403 Penn Avenue, Pittsburg, Pa. (50).

*Laudy, Louis H., Ph. D., School of Mines, Columbia University, New York, N. Y. (28). 1890. **C**

Lauman, George Nieman, Instructor in Horticulture, Cornell University, Ithaca, N. Y. (50). **G**

Lavers, Enoch C., Teacher of Mathematics, 126 Porter St., Easton, Pa. (54). **A**

Law, Benedict W., Collins, N. Y. (45). **E**

Lawbaugh, Elmer Arthur, Oregonian Building, Portland, Oregon. (52). **K**

Lawrence, A. E., 53 Devonshire St., Boston, Mass. (49). **B**

Lawrence, Florus F., M. D., Chief of Staff and Surgeon, Lawrence Hospital for Women, 423 East Town St., Columbus, Ohio. (53). **K**

Lawrence, Harry E., Univ. of Rochester, Rochester, N. Y. (44). **B**

Lawrence, James W., Professor of Mechanical Engineering, Agricultural College, Fort Collins, Colo. (50). **D**

Laws, Frank Arthur, Mass. Institute Technology, Boston, Mass. (47).

Laws, Samuel Spahr, LL. D., 1733 Q St., N.W., Washington, D. C. (52). **H**

*Lawson, Andrew C., Professor of Geology and Mineralogy, University of California, Berkeley, Cal. (50). 1901. **E**

Lay, Henry Champlin, Civil and Mining Engineer and Geologist, U. S. Deputy Mineral Surveyor, Telluride, Colo. (51). **D E**

Lazell, Ellis W., Ph. D., 1619 Filbert St., Philadelphia, Pa. (51). **C**

*Lazenby, W. R., Columbus, Ohio. (30). 1882. **B I**

Lea, Henry C., 2000 Walnut St., Philadelphia, Pa. (54).

*Leach, Miss Mary F., 74 Pitcher St., Detroit, Mich. (44). 1896. **C**

*Leaming, Edward, 437 West 59th St., New York, N. Y. (50). 1901. **C**

*Leavitt, Frank M., Mechanical Engineer, 258 Broadway, New York, N. Y. (51). 1903. **D**

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*Le Brun, Mrs. Michel M., 8 Mountain Ave., S., Montclair, N. J. (35). 1892. **F**

Le Conte, Louis Julian, Civil Engineer, P. O. Box 482, Oakland, Cal. (51). **D**

Le Conte, Robert Grier, M. D., 1625 Spruce St., Philadelphia, Pa. (51). **K**

*Ledoux, Albert R., Ph. D., 99 John St., New York, N. Y. (26). 1881. **C**

Lee, Benjamin, M. D., Secretary State Board of Health, 1420 Chestnut St., Philadelphia, Pa. (51). **K**

Lee, Edwin, Professor of Physics and Chemistry, Mt. Union College, Alliance, Ohio. (53). **B C F**

*Lee, Frederic S., Adjunct Professor of Physiology, Columbia University, New York, N. Y. (49). 1901. **K**.

Lee, Leslie A., Professor of Biology, Bowdoin College, Brunswick, Me. (52). F

Lee, Waldemar, 4620 Wayne St., Philadelphia, Pa. (50).

Lee, William George, Harvard Medical School, Boston, Mass. (50). H K

*Lee, Willis Thomas, U. S. Geological Survey, Washington, D. C. (47). 1902. E F

Leeds, Morris E., 3221 North 17th St., Philadelphia, Pa. (50). D

*Lefavour, Henry, President Simmons College, Boston, Mass. (42). 1894. B

LeGras, Gustave, Asst. Prof. Mathematics, College of the City of N. Y., New York, N. Y. (54). A

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Lehmann, Leslie P., 32 South St., Baltimore, Md. (52).

Leidy, Joseph, Jr., M. D., 1319 Locust St., Philadelphia, Pa. (51). K

Leisen, Theo. Alfred, Civil Engineer, Wilmington, Del. (51). B C D G

Leith, Charles Kenneth, Professor of Economic and Structural Geology, University of Wisconsin, Madison, Wis. (53). E

Leland, Ora Miner, College of Civil Engineering, Cornell Univ., Ithaca, N. Y. (54). A D

Lemley, C. McC., Asst. Engineer, B. & O. R. R. Co., Second National Bank Bldg., Uniontown, Pa. (51). D

Lemon, James S., Ph. D., 31 Park St., Gardner, Mass. (51). I K

Leng, Charles W., 119 Columbia St., West New Brighton, Staten Island, N. Y. (54). F

*Lengfeld, Felix, Ph. D., Consulting and Manufacturing Chemist, 202 Stockton St., San Francisco, Cal. (51). 1903. C

*Lenher, Victor, Ph. D., Assistant Professor of Chemistry, Univ. of Wisconsin, Madison, Wis. (52). 1903. C

*Lennon, William H., State Normal School, Brockport, N. Y. (31). 1894. C G

Leonard, Chas. Lester, M. D., 112 S. 20th St., Philadelphia, Pa. (51). K

Leonard, John William, Editor of "Who's Who in America," Wheaton, Ill. (50). I

Lesley, Robert W., 604 Pennsylvania Building, Philadelphia, Pa. (54).

Letson, Miss Elizabeth J., Buffalo Society of Natural Sciences, Buffalo, N. Y. (47).

Levene, Dr. P. A., 129 West 136th St., New York, N. Y. (53). K

*Leverett, Frank, 312 N. Thayer St., Ann Arbor, Mich. (37). 1891. E

Leverson, Montague Richard, M. D., 81 Lafayette Ave., Brooklyn, N. Y. (54). K

Levy, Ernest C., M. D., 615 East Franklin St., Richmond, Va. (54). C K

Lewis, Miss Bertha, Acorn Club, 1618 Walnut St., Philadelphia, Pa. (54).

LEWIS, CLARENCE MCKENZIE, care Wm. Salomon & Co., 25 Broad St., New York, N. Y. (47). D

*Lewis, E. Percival, Associate Professor of Physics, University of California, Berkeley, Cal. (53). 1905. B

Lewis, George Smith, 746 State St., Springfield, Mass. (44). G

*Lewis, J. Volney, Rutgers College, New Brunswick, N. J. (45). 1900. C E

Lewis, Wilfred, Pres. The Tabor Mfg. Co., 5901 Drexel Road, Philadelphia, Pa. (51). D

Lewton, Frederick Lewis, U. S. Dept. Agriculture, Washington, D. C. (54). F G

*Libbey, Prof. William, Princeton, N. J. (29). 1887. E F

Lichthardt, G., Jr., 1800 M St., Sacramento, Cal. (50). C

Lichty, Daniel, M. D., Masonic Temple, Rockford, Ill. (52). K

Lieber, Hugo, 25 West Broadway, New York, N. Y. (53). C

Light, Dr. Gertrude Underhill, Women's University Club, 10 Gramercy Park, New York, N. Y. (53). K

Lightfoot, Thos. Montgomery, Asst. Prof. of Physical Science, Central High School, Philadelphia, Pa. (51). G

Lightner, Calvin R., M. D., 2313 Washington Ave., St. Louis, Mo. (53). K

*Lillie, Frank R., Professor of Zoology, University of Chicago, Chicago, Ill. (50). 1901. F

*Lincoln, Paul Martyn, Electrical Engineer, Pittsburg, Pa. (50). 1903. D

Lindenkohl, Henry, U. S. C. and G. Survey, Washington, D. C. (47).

*Lindenthal, Gustav, C. E., 45 Cedar St., New York, N. Y. (37). 1891. I

Lindgren, Waldemar, U. S. Geological Survey, Washington, D. C. (53). E

*Lindley, Ernest H., Professor Psychology, University of Indiana, Richmond, Ind. (52). 1905. K

Lindsay, Alexander M., Rochester, N. Y. (41).

Lindsay, Samuel McCune, Prof. of Sociology, Univ. of Pa., Philadelphia, Pa. (54). I

Lindsey, Edward, Warren, Pa. (48). H I

Lines, Edwin Fuller, U. S. Geological Survey, Washington, D. C. (54). E

Linford, James Henry, President of the Brigham Young College, Logan, Utah. (52). F

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*Reese, Charles L., 1020 Jackson St., Wilmington, Del. (39). 1892. C

Reese, Herbert M., Yerkes Observatory, Williams Bay, Wis. (49). B

*Reese, Jacob, Darby, Pa. (33). 1891. B D

Reichmann, Fritz, Troy, N. Y. (54). B

*Reid, Harry Fielding, Johns Hopkins University, Baltimore, Md. (36). 1893. B

*Reid, Hon. Whitelaw, 451 Madison Ave., New York, N. Y. (50). 1901. I

Reifsnyder, Samuel K., 705 Bond St., Asbury Park, N. J. (50). I

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*Reighard, Jacob, Prof. of Zoology, Univ. of Michigan, Ann Arbor, Mich. (51). 1903. F

Reist, Henry G., Mechanical and Electrical Engineer, 5 South Church St., Schenectady, N. Y. (50). D

Remington, Prof. Joseph Price, 1832 Pine St., Philadelphia, Pa. (54). K

*Remsen, Ira, President Johns Hopkins University, Baltimore, Md. (22). 1875. C

Renninger, John S., M. D., Marshall, Minn. (31). C F

Reynolds, Dudley Sharpe, M. D., 304 W. Chestnut St., Louisville, Ky. (50). K

Reynolds, George, P. O. Box B, Salt Lake City, Utah. (44). H

*Rhodes, James Ford, Author and Historian, 392 Beacon St., Boston, Mass. (50). 1903. I

Rice, Calvin Winsor, Consulting Engineer, General Electric Co., 44 Broad St., New York, N. Y. (51). B D

*Rice, Edward L., A. B., Ohio Wesleyan University, Delaware, Ohio. (43). 1905. F

Rice, Edwin Wilbur, Jr., General Electric Co., Schenectady, N. Y. (50). D

Rice, Martin Everett, Asst. Professor of Physics and Electrical Engineering, University of Kansas, Lawrence, Kans. (50). B D

*Rice, Prof. W. North, Wesleyan University, Middletown, Conn. (18). 1874. **E F**

Rich, Michael P., M. D., 50 W. 38th St., New York, N. Y. (40).

Richard, Montrose R., M. D., 114 West 116th St., New York, N. Y. (51). **K**

*Richards, Charles B., 237 Edwards St., New Haven, Conn. (33). 1885. **D**

*RICHARDS, EDGAR, 341 W. 88th St., New York, N. Y. (31). 1886. **C**

*Richards, Herbert Maule, Ph. D., Instructor in Botany, Barnard College, Columbia University, New York, N. Y. (51). 1902. **G**

*Richards, Prof. Robert H., Mass. Institute of Technology, Boston, Mass. (22). 1875. **D**

*Richards, Mrs. Robert H., Mass. Institute of Technology, Boston, Mass. (23). 1878. **C**

*Richards, Prof. Theodore William, Harvard University, Cambridge, Mass. (47). 1899.

Richardson, Major Charles A., Canandaigua, N. Y. (50). **I**

Richardson, Charles Henry, Ph. D., Department of Mineralogy, Dartmouth College, Hanover, N. H. (47). **C E**

Richardson, Charles Williamson, M. D., 1317 Connecticut Ave., N. W., Washington, D. C. (49).

*Richardson, Clifford, Barber Asphalt Paving Co., Long Island City, N. Y. (30). 1884. **C**

*Richardson, Miss Harriet, Smithsonian Institution, Washington, D. C. (49). 1903. **F**

Richardson, Leon B., 3443 Chestnut St., Philadelphia, Pa. (52). **C**

*Richardson, Mark Wyman, M. D., 90 Equitable Building, Boston, Mass. (51). 1903. **K**

Richardson, Wm. D., P. O. Box 185, Fredericksburg, Va. (52). **C F**

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Richmond, William Henry, 3425 North Main Ave., Scranton, Pa. (50). **E**

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Rickard, T. A., Editor of "The Engineering and Mining Journal," 261 Broadway, New York, N. Y. (50). **D E**

]Ricker, Maurice, Principal of High School, Burlington, Iowa. (50). **F**

Ricker, N. Clifford, Dean of the College of Engineering, University of Illinois, Urbana, Ill. (50). **D**

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Ricketts, Louis D., Consulting Mining Engineer, Globe, Arizona. (50). **D E**

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*Ries, Heinrich, Ph. B., Ithaca, N. Y. (41). 1898. E

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Rietz, Henry Lewis, University of Illinois, Urbana, Ill. (51). A

Riggs, Norman Colman, Assoc. Prof. Mathematics, Armour Inst. of Tech., Chicago, Ill. (54). A

*Riggs, Robert Baird, Ph. B., Professor of Chemistry, Trinity College, Hartford, Conn. (50). 1901. C

Riker, Clarence B., Maplewood, N. J. (52). F

Riker, Samuel, 27 E. 69th St., New York, N. Y. (50).

Riley, Cassius M., Professor of Chemistry, Barnes Medical College and Barnes College of Pharmacy, St. Louis, Mo. (53). C

*Riley, Isaac Woodbridge, Ph. D., Johns Hopkins Univ., Baltimore, Md. (52). 1903. H I

Riley, Mrs. Matilda E., Art Director, St. Louis Public Schools, Board of Education Building, St. Louis, Mo. (53).

Riley, William Albert, Ph. D., Instructor in Entomology, Cornell University, Ithaca, N. Y. (54). F

Rissmann, Otto, General Manager, Cockerill Zinc Co., Nevada, Mo. (50). D E

Ritchie, Craig D., Conveyancer, 414 N. 34th St., Philadelphia, Pa. (51).

*Ritter, William Emerson, Associate Professor of Zoology, University of California, Berkeley, Cal. (50). 1901. F

Roark, Ruric Nevel, Prof. of Pedagogy, Kentucky State College, Lexington, Ky. (54). I

Robb, Hunter, M. D., 702 Rose Building, Cleveland, Ohio. (51). K

Robb, J. Hampden, 23 Park Ave., New York, N. Y. (50).

Robert, Henry Martyn, Brig.-Gen., U. S. A., Owego, N. Y. (54). D I

Robert, Dr. J. C., A. and M. College, Agricultural College, Miss. (51).

Roberts, H. L., Department of Biology, Western Illinois State Normal School, Macomb, Ill. (52). F

Roberts, Miss Jennie B., 231 William St., Port Chester, N. Y. (43).

Roberts, Milnor, Professor of Mining and Metallurgy, University of Washington, Seattle, Wash. (50). **D E**

Roberts, Thomas Paschall, Civil Engineer, 361 North Craig St., Pittsburg, Pa. (51). **D**

Roberts, Wm. F., 730 15th St., Washington, D. C. (52). **F I**

Robertson, Alice, Assistant in Zoology, University of California, Berkeley, Calif. (54). **F**

Robertson, Charles, Carlinville, Ill. (53). **F**

*Robinson, Benjamin Lincoln, Curator Harvard Herbarium, Cambridge, Mass. (41). 1893. **G**

*Robinson, Mrs. Daisy M. Orleman, M. D., 159 W. 49th St., New York, N. Y. (40). 1897. **F K**

*Robinson, Prof. Franklin C., Bowdoin College, Brunswick, Me., (29). 1889. **C D**

*Robinson, Otis Hall, Professor of Natural Philosophy, University of Rochester, Rochester, N. Y. (23). 1901. **A B**

Robinson, Samuel Adams, M. D., Covesville, Va. (51). **H I K**

Robinson, Sanford, C. E., E. M., Steeple Rock, New Mexico. (50). **D**

*Robinson, Prof. Stillman W., 1353 Highland St., Columbus, Ohio. (30). 1883. **A B D**

Rochester, DeLancey, M. D., 469 Franklin St., Buffalo, N. Y. (35). **F**

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*Rolfs, Peter H., Tropical Laboratory U. S. Department Agriculture, Miami, Fla. (41). 1899. **G**

Rollins, William Herbert, M. D., 250 Marlborough St., Boston, Mass. (50). **B K**

*Rominger, Dr. Carl, Ann Arbor, Mich. (21). 1879. **E**

*Root, Hon. Elihu, Secretary of State, Washington, D. C. (50). 1901. **I**

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*Rose, Joseph Nelson, U. S. National Museum, Washington, D. C. (52). 1905. G

Rose, Lewis H., Associate Prof., Chemistry and Physics, Univ. of Arkansas, Fayetteville, Ark. (52). B C

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Ross, Bennett Battle, Professor of Chemistry, Alabama Polytechnic Institute, Auburn, Ala. (45). C

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*Rotch, A. Lawrence, Director of Blue Hill Meteorological Observatory, Hyde Park, Mass. (39). 1896. B

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*Rowlee, W. W., Cornell Univ., Ithaca, N. Y. (41). 1894. G

Roy, Arthur J., C. E., Dudley Observatory, Albany, N. Y. (50). A

Rucker, Miss Augusta, University of Texas, Austin, Texas. (51).

Ruddick, William H., M. D., So. Boston, Mass. (51). F K

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Ruger, Henry A., Prof. of Psychology, Colorado College, Colorado Springs, Colo. (54). H K

Ruland, Frederick D., M. D., Westport, Conn. (51). B C K

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Running, Theodore R., Ph. D., Dept. of Engineering, Univ. of Michigan, Ann Arbor, Mich. (50). A

Rupp, August, A. B., College of City of New York, New York, N. Y. (35).

Ruppersberg, Miss Emma A., 554 West 125th St., New York, N. Y. (48). B

*Rusby, Henry H., M. D., 115 West 68th St., New York, N. Y. (36). 1890. G

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Russell, A. H., Lieut. Col. U. S. A., Ordnance Office, War Dept., Washington, D.C. (38). D

*Russell, Prof. H. L., University of Wisconsin, Madison, Wis. (41). 1894. G

Russell, Henry Norris, The Observatory, Cambridge, England. (54). A

*Russell, Israel C., University of Michigan, Ann Arbor, Mich. (25). 1882. E

*Russell, James E., Dean of Teachers' College, West 120th St., New York, N. Y. (50). 1901. H I

Russell, John B., Superintendent of Schools, Wheaton, Ill. (51). C

Russell, Dr. Thomas Hubbard, 137 Elm St., New Haven, Conn. (54). K

Ruthven, Alex. G., Univ. Museum, Ann Arbor, Mich. (54). F

*Rutter, Frank Roy, Ph. D., U. S. Dept. Agriculture, Washington, D. C. (47). 1900. I

*Ryan, Harris J., Cornell University, Ithaca, N. Y. (38). 1890. B

*Rydberg, Dr. Per Axel, N. Y. Botanical Garden, Bronx Park, New York, N. Y. (49). 1901. G

*Sabine, Wallace Clement, 40 Shepard St., Cambridge, Mass. (47). 1900. B

*Sachs, B., M. D., 21 E. 65th St., New York, N. Y. (49). 1903. K

Sackett, Miss Eliza D., Cranford, N. J. (35).

Sackett, Robert L., C. E., Professor of Civil Engineering, Earlham College, Richmond, Ind. (50). A

Sackett, Walter George, Agricultural College, Mich. (52). F G

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Safford, Frederick Hollister, Ph. D., Univ. of Pennsylvania, Philadelphia, Pa. (54). A

Sage, John Hall, Portland, Conn. (23). F

*St. John, Prof. Charles E., 125 Elm St., Oberlin, Ohio. (46). 1900. B

Sajous, Charles Euchariste de Médicis, No. 43 Walnut St., Philadelphia, Pa. (54). K

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*Salisbury, Prof. R. D., Chicago University, Chicago, Ill. (37). 1890. B E

*Salmon, Daniel E., Washington, D. C. (31). 1885. F
Sampson, Alden, Haverford, Pa. (54). F
Sander, Dr. Enno, St. Louis, Mo. (27). C
Sanders, James G., U. S. Dept. Agriculture, Washington, D. C. (54). F
*Sanderson, E. Dwight, Agr. Exp. Sta., Durham, N. H. (50). 1903. F
Sando, Will J., care Allis-Chalmers Co., Milwaukee, Wis. (51). E
Sandsten, E. P., Univ. of Wisconsin, Madison, Wis. (54).
Sanes, K. I., M. D., 1636 5th Ave., Pittsburg, Pa. (51). K
*Sanford, E. C., Professor of Psychology, Clark University, Worcester, Mass. (49). 1902. H I
*Sanford, Fernando, Professor of Physics, Stanford University, Cal. (50). 1901. B
Sardeson, Frederick William, Ph. D., Instructor in Geology, University of Minnesota, Minneapolis, Minn. (50). E
Sargent, Ara Nathaniel, M. D., 116 Federal St., Salem, Mass. (51). K
*Sargent, Dudley Allen, M. D., Director of the Hemenway Gymnasium, Harvard University, Cambridge, Mass. (47). 1899. H
Sargent, Frederick Le Roy, 27 Everett St., Cambridge, Mass. (54). G
Sargent, Winthrop, Haverford, Pa. (54). D
Satterlee, F. LeRoy, M. D., 8 W. 18th St., New York, N. Y. (50). K
*Saunders, A. P., Ph. D., Hamilton College, Clinton, N. Y. (48). 1900. C
*Saunders, Charles E., Ph. D., Central Experimental Farm, Ottawa, Canada. (41). 1895. G
Saunders, Edward W., M. D., 3003 Lafayette Ave., St. Louis, Mo. (51). K
Saunders, F. A., Ph. D., Instructor in Physics, Syracuse University, Syracuse, N. Y. (48). B
Saunders, Dr. James, Lock Box 147, Orange, Texas. (52).
*Saunders, William, LL.D., F. R. S. C., F. L. S., Canadian Experimental Farms, Ottawa, Canada. (17). 1874. F
Saunders, Wm. H., 1407 F St., N.W., Washington, D. C. (52). I
Savage, Thomas E., Assistant State Geologist, Iowa Geological Survey, Des Moines, Iowa. (52). E F G
*Savage, Watson L., M. D., Mamaroneck, N. Y. (51). 1902. K
*Saville, Marshall H., Amer. Mus. Nat. History, Central Park, New York, N. Y. (39). 1892. H
Sawyer, Edward, Civil and Mechanical Engineer, Newton, Mass. (51). D
Sayre, Herbert Armistead, Prof. Physics and Astronomy, Univ. of Alabama University, Ala. (54). A B
*Sayre, Robert H., South Bethlehem, Pa. (28). 1899. D
Scaife, Walter B., care A. W. Elford, Catania, Sicily. (49). I

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Schaeffer, Henri N. F., P. O. Box 169, Greenville, S. C. (46). C
Schaffer, Mrs. Mary Townsend Sharpless, 1309 Arch St., Philadelphia, Pa. (38). E F
*Schaffner, John H., Ohio State University, Columbus, Ohio. (48). 1899. G
Schaller, Waldemar T., U. S. Geological Survey, Washington, D. C. (53). E
Scharar, Christian H., 2073 N. Main Ave., Scranton, Pa. (33). A D E H
Schenck, Charles C., Ph. D., McGill University, Montreal, Canada. (51). B
Scherf, C. Harry, 114 Marietta St., Burlington, Iowa. (53). F
Schermerhorn, F. Aug., 101 University Place, New York, N. Y. (36).
Schermerhorn, Wm. C., 49 West 23d St., New York, N. Y. (36).
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Schiedt, Richard Conrad, Professor of Biology, Franklin and Marshall College, Lancaster, Pa. (50). F
Schieffelin, Eugene, 865 Madison Ave., New York, N. Y. (50).
Schiertz, Ferdinand Alfred, Maconi, Distrito de Cadereyta, Estado de Queretaro, Mexico. (50). D E
*Schlesinger, Frank, Yerkes' Observatory, Williams Bay, Wis. (51). 1902. A
Schlichting, Emil, Analytical Chemist, 38 Cranberry St., Brooklyn, N. Y. (50). C
*Schlotterbeck, Julius O., 1319 Israel Hall Ave., Ann Arbor, Mich. (46). 1899. G
*Schmeckebier, Lawrence Frederick. Ph. D., U. S. Geol. Survey, Washington, D. C. (50). 1902. E I
Schmid, Dr. H. Ernest, White Plains, N. Y. (25).
Schmitt, A. Emil, M. D., 103 East 60th St., The Palermo, New York, N. Y. (50). K
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Schmucker, Samuel Christian, Ph. D., Professor of Biology, Normal School, West Chester, Pa. (53). F G
Schneider, Albert, Cal. College Pharmacy, Parnassus Ave., San Francisco, Cal. (54). C

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Schobinger, John J., Morgan Park, Ill. (34). B

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Schultz, Louis G., Coast and Geodetic Survey, Magnetic Observatory, Chiltenham, Md. (52). B

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Schuyler, Philip, Irvington-on-Hudson, N. Y. (49).

Schwab, Dr. Sidney I., 4393 Westminster Place, St. Louis, Mo. (52). K

*Schwarz, E. A., U. S. Department of Agriculture, Washington, D. C. (29). 1895. F

*Schwatt, Isaac Joachim, Assistant Professor of Mathematics, University of Pennsylvania, Philadelphia, Pa. (51). 1902. A

*Schweitzer, Paul, Professor of Chemistry, State Univ. of Missouri, Columbia, Mo. (24). 1877. B C

Scofield, Carl S., Department of Agriculture, Washington, D. C. (52). G

Scott, Prof. Arthur William, St. David's College, Lampeter, S. Wales, England. (46). A B

*Scott, Charles F., Westinghouse Electric and Mfg. Co., Pittsburg, Pa. (48). 1900. B

Scott, W. M., U. S. Dept. Agriculture, Washington, D. C. (50). F

Scovel, Edward C., Rosebud, S. Dak. (52).

*Scovell, M. A., Director and Chemist, Agricultural Experiment Station, Lexington, Ky. (35). 1887. C

Scripture, Arthur M., Principal of High School, New Hartford, N. Y. (51). D

*Scripture, E. W., Phonetic Laboratory, Rigistr, 47, Zurich, Switzerland. (46). 1901. H

*Scudder, Samuel H., Cambridge, Mass. (13). 1874. F

*Scull, Miss Sarah A., Smethport, Pa. (40). 1895. H

Seal, Alfred Newlin, Ph. D., Professor of Chemistry, Girard College, Philadelphia, Pa. (50). B C

Seaman, Arthur Edmund, Professor of Geology and Mineralogy, Michigan College of Mines, Houghton, Mich. (53). E

*Seaman, W. H., Chemist, 1424 11th St. N.W., Washington, D. C. (23). 1874. **C F**

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Sears, Frederick Edmund, St. Paul's School, Concord, N. H. (47). **C E**

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Seawell, Benjamin Lee, Teacher of Biology, State Normal School, Warrensburg, Mo. (50). **F**

Secor, William Lee, Academia, Ohio. (52). **C**

Sedgwick, Howard M., M. D., 512 Woolner Bldg., Peoria, Illinois. (52). **B C K**

*Sedgwick, William Thompson, Massachusetts Institute of Technology, Boston, Mass. (47). 1898. **F G**

See, James W., M. E., Opera House, Hamilton, Ohio. (51). **D**

*See, Prof. T. J. J., Observatory, Mare Island, Cal. (48). 1901. **A**

Seelig, Major G., M. D., Vanol Bld'g, 3908 Olive St., St. Louis, Mo. (54). **K**

Segerblom, Wilhelm, Professor of Chemistry, Phillips Exeter Academy, Exeter, N. H. (53). **C**

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Sellards, Elias Howard, Prof. Zoology & Geology, Univ. of Florida, Lake City, Fla. (54). **E F**

Sellers, James Freeman, Prof. of Chemistry, Mercer University, Macon, Ga. (50). **C**

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Sessinghaus, Gustavus, E. M., 1360 Columbine St., Denver, Colo. (50). **E**

Sever, George F., Electrical Engineer, Broadway and 117th St., New York, N. Y. (49). **B**

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Shafer, John A., Custodian of the Museums, N. Y. Botanical Garden, Bronx Park, New York, N. Y. (51). **G**

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Shamel, Archibald D., U. S. Dept. of Agriculture, Washington, D. C. (52). G

*Shantz, Homer LeRoy, 1420 Vine St., Lincoln, Neb. (50). 1903. F

Sharp, Charles Cutler, C. E., E. M., Gauley Bridge, W. Va. (50). D E

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Sharpe, Richard W., Wilmette, Ill. (51). F

Sharples, Philip Price, A. B., 22 Concord Ave., Cambridge, Mass. (47). C

*Sharples, Stephen P., 26 Broad St., Boston, Mass. (29). 1884. C

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Shattuck, George Brune, M. D., 183 Beacon St., Boston, Mass. (54). K

*Shattuck, George Burbank, Johns Hopkins University, Baltimore, Md. (47). 1899. E

Shattuck, John D., 517 Market St., Chester, Pa. (54). D

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Shaw, Dr. Charles Hugh, Ursinus College, Collegeville, Pa. (52). G

Shaw, Edwin C., M. E., 104 Park St., Akron, Ohio. (50). D

Shaw, Henry Clay, C. E., Glenshaw, Pa. (51). D

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*Ware, Wm. R., Milton, Mass. (36). 1901. D

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Warman, P. C., Geological Survey, Washington, D. C. (53). G

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Warren, Rt. Rev. Henry White, Bishop M. E. Church, University Park, Colo. (50). A

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*Warren, Joseph W., M. D., Bryn Mawr, Pa. (31). 1886. F

*Warren, S. Edward, Newton, Mass. (17). 1875. A I

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Washburn, George Hamlin, Prof. of Obstetrics, Tufts Medical School, Boston, Mass. (54). K

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*Washington, Dr. Henry S., Locust, N. J. (44). 1897. E

Waterhouse, James Smartt, Professor of Chemistry and Natural Science, Cumberland University, Lebanon, Tenn. (50). C F G

Waterman, Frank Allan, Prof. of Physics, Smith College, Northampton, Mass. (54). B

Waterman, Warren Gookin, Prof. of Physics and Geology, Fisk University, Nashville, Tenn.

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Waugh, James Church, Mount Vernon, Washington. (52).
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Weaver, Edwin Oscar, Professor of Physics and Biology, Wittenberg College, Springfield, Ohio. (51). **B F G**
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*Webber, Herbert J., U. S. Dept. Agriculture, Washington, D. C. (47). 1900. **G**
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Webster, Edgar H., Professor of Physical Science, Atlanta University, Atlanta, Ga. (50). **B**
*Webster, F. M., U. S. Dept. Agriculture, Washington, D. C. (35). 1890. **F**
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Weems, Mason Locke, Instructor in Physiology, Valparaiso College, Valparaiso, Ind. (52). **K**

Weidman, Samuel, Geologist, Wisconsin State Geological and Natural History Survey, Madison, Wis. (53). **E**

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Welin, John E., Professor of Physics, Chemistry and Geology, Bethany College, Lindsborg, Kansas. (50). **B C E**

Weller, Stuart, University of Chicago, Chicago, Ill. (54). **E F**

Wells, Eliab Horatio, M. D., Professor of Natural Science, Baylor Female College, Belton, Texas. (50). **F K**

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*Wheeler, Henry Lord, Sheffield Lab., New Haven, Conn. (50), 1901. C

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*Whitman, Prof. Frank P., Adelbert College, Cleveland, Ohio. (33). 1885. A B

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*Wilbur, Ray Lyman, M. D., Assistant Professor of Physiology, Stanford University, Cal. (50). 1901. F K

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*Wilcox, Edwin Mead, Ph. D., Prof. of Biology and Plant Physiologist and Pathologist, Ala. Poly. Inst., Auburn, Ala. (50). 1901. F G

Wilcox, Miss Emily T., Middletown, Conn. (33). A B

Wilcox, Guy Maurice, Professor of Physics, Armour Institute, Chicago, Ill. (53). **B**

*Willcox, Miss Mary Alice, Ph. D., Professor of Zoology, Wellesley College, Wellesley, Mass. (50). 1901. **F**

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*Wilder, Harris Hawthorne, Ph. D., Professor of Zoology, Smith College, Northampton, Mass. (52). 1905. **F**

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*Wilkinson, Levi Washington, Professor of Industrial and Sugar Chemistry, Tulane University, New Orleans, La. (50). 1903. **C**

Willard, Julius Terrass, Dir. Kans. State Exper. Sta., Manhattan, Kans. (50). **C**

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Williams, Clarke Benedict Olney, Prof. of Mathematics, Kalamazoo College, Kalamazoo, Mich. (54). **A**

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Williams, Frank H., Greene, N. Y. (50). **D**

Williams, Harvey Ladew, P. O. Box 410, Bristol, Tenn. (53). **C E**

*Williams, Prof. Henry Shaler, Cornell University, Ithaca, N. Y. (18). 1882. **E F**

Williams, Herbert U., M. D., Prof. of Pathology and Bacteriology, University of Buffalo, Buffalo, N. Y. (54). **K**

Williams, Ira Abraham, Iowa State College, Ames, Iowa. (52). **D E**

Williams, J. C., 221 Orchard St., Ridgeway, Pa. (51). **E**

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Williams, Leonard Worcester, Brown University, Providence, R. I. (52).

Williams, Miss Mabel Clare, Iowa City, Iowa. (52). **H**

Williams, Stephen Riggs, Professor of Biology, Miami University, Oxford, Ohio. (50). **F**

Williamson, Edward Bruce, Bluffton, Ind. (50). **F**

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Wilson, Prof. Andrew G., Hebron, Neb. (43). **E**

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Wilson, Delonza Tate, Assistant Professor of Mathematics and Astronomy, Case School of Applied Science, Cleveland, Ohio. (53). **A**

*Wilson, E. B., Columbia University, New York, N. Y. (49). 1900.

Wilson, Fredk. Morse, M. D., 834 Myrtle Ave., Bridgeport, Conn. (51). **K**

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Wilson, John C., Cosmos Club, Washington, D. C. (49). I

Willson, Mortimer, M. D., Port Huron, Mich. (50). A F

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Wilson, William Hyatt, Prof. of Mathematics, Univ. of Wooster, Wooster, Ohio. (50). A

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*Winchell, Alexander Newton, Professor of Geology and Mineralogy, State School of Mines, Butte, Mont. (50). 1903. E

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Witte, Max Ernest, M. D., Superintendent of Clarinda State Hospital, Clarinda, Ia. (51). K

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Wolcott, Edson Ray, Prof. of Physics, Colorado School of Mines, Golden, Colo. (54). B

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Woodhull, Gen. Maxwell Van Zandt, U. S. A., 2033 G St., N.W., Washington, D. C. (52).

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TUFTS COLLEGE.

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MICHIGAN.

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Craig, Moses.
Sackett, Walter George.

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LANSING.

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Koch, Waldemar, University of Missouri.
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NEBRASKA.

ASHLAND.

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BELLEVUE.

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CREIGHTON.

Burrell, Rámon Haddock.

FREMONT.

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HEBRON.

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RENO.

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UNIVERSITY PLACE.

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WAHOO.

Bush, John C. F.

NEVADA.

GOLDFIELD.

Patrick, Edward T., Drawer C.

TYBO.

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NEW HAMPSHIRE.

ANDOVER.

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Rockey, A. E., 778 Flanders Street.
Sheldon, Edmund P.

PANAMA.

BOCAS DEL TORO.

McKenny, Randolph E. B., care United Fruit Co.

PENNSYLVANIA.

ALLEGHENY.

Albree, Chester B., 14–30 Market Street.
Boucek, Anthony J., 624 Chestnut Street.
Brashear, John A.
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Smith, Miss Matilda H., 40 Library Place.
Snyder, William E., 510 East North Avenue.
Turnbull, Thomas, Jr., Allegheny University.
Wadsworth, F. L. O., Western University of Pennsylvania.

ALLENTOWN.

Kress, Palmer J., 24 South Seventh Street.

ALTOONA.

Dudley, Charles B., Drawer 156.

ANNVILLE.

McFadden, Thomas Gilbert, Lebanon Valley College.

ASPINWALL.

Buckwall, Edward Wiley.

ATHENS.

Stevens, Cyrus Lee.

BEAVER.

Hice, Richard R.

BERWICK.

McDowell, Edward Campbell, 107 Walnut Street.

BETHLEHEM.

Lambert, Preston A., 215 South Center Street.
Laramy, Robert Edward, 27 North New Street.
Rau, Albert George, 63 Broad Street.
Whitehouse, Wm. Risby, 87 Market Street.

BLOOMSBURG.

Hartline, D. S., State Normal School.

BROOKVILLE.

Jenks, William H.

BRYN MAWR.

Bascom, Miss Florence, Bryn Mawr College.
Keasbey, Lindley M., Bryn Mawr College.
King, Helen Dean, Box 93.
Miller, Benjamin Le Roy, Bryn Mawr College.
Springstern, Harry W.
Stevens, Nettie Maria.
Warren, Joseph W.

CALIFORNIA.

Harmon, Herbert W., South-Western State Normal School.
Schuh, Richard Edwin.

CARLISLE.

Himes, Charles F.
Landis, W. W., Dickinson College.
Mohler, John F., Dickinson College.
Pratt, R. H., U. S. Indian Industrial School.
Spangler, Harry Allen.
Stephens, Henry Matthew, Dickinson College.
Strock, John Roy, 337 N. Hanover Street.

CHESTER.

Heffrin, Harry, 212 West 7th Street.
Shattuck, John D., 517 Market Street.

COLLEGEVILLE.

Shaw, Charles Hugh, Ursinus College.

COLUMBIA.

Craig, Alexander Righter, 232 Cherry Street.

CONSHOHOCKEN.

Clark, Arthur W.

COOPERSBURG.

Boyé, Martin H.

DARBY.

Reese, Jacob.

DOYLESTOWN.

Fretz, A. Henry.
Mercer, H. C.

DRIFTON.

Coxe, Eckley B., Jr.

EASTON.

Brasefield, Stanley E., Lafayette College.
Coffin, Selden J., Lafayette College.
Davison, Alvin, Lafayette College.
Eyerman, John, "Oakhurst."
Firmstone, F.
Fretz, John Edgar, 120 North 3d Street.
Green, Edgar Moore.
Hall, William S., Lafayette College.
Hart, Edward, Lafayette College.
Hellick, Chauncey Graham, Lafayette College.
Lavers, Enoch C., 126 Porter Street.
Moore, J. W., Lafayette College.
Ott, Isaac.
Peck, Frederick B., Lafayette College.
Sherwood-Dunn, B.
Shimer, Porter W.

ELYSBURG.

Allison, C. E.

EMPORIUM.

Van Gelder, Arthur P., Climax Powder Mfg. Co

ERIE.

Dunn, Ira J., 810 Peach Street.
Heisler, Chas. L., 909 North 8th Street.

FRANKLIN.

Conradson, Pontus H., Galena Signal Oil Company.

GERMANTOWN.

Brown, Stewardson, 20 East Penn Street.
Carter, John E., Knox and Coulter Streets.
Fox, Henry, 5603 Germantown Avenue.
Haines, Reuben, Haines and Chew Streets.
Meehan, S. Mendelson.

GETTYSBURG.

Stahley, George D.

GLENOLDEN.

Kinyoun, J. J.

GLENSHAW.

Shaw, Henry Clay.

GREENSBURG.

Zuber, William H., Greensburg Seminary.

HARRISBURG.

Demming, Henry Clay.
Jacobs, Michael William, 222 Market Street.
McCreath, Andrew S., 223 Market Street.
O'Connor, Haldeman, 13 North Front Street.

HAVERFORD.

Babbitt, James A., Haverford College.
Brown, Ernest William, Haverford College.
Hall, Lyman B., Haverford College.
Sampson, Alden.
Sargent, Winthrop.

HAZLETON.

Dietz, William G., 21 N. Vine Street.

HUNTINGDON VALLEY.

Bellows, Horace M.

KUSHEQUA.

Kane, Elisha Kent.

LANCASTER.

Beck, Herbert H., Y. M. C. A. Building.
Gardiner, Frederic, Jr., Yeates School.
Kershner, Jefferson E.
Schiedt, Richard Conrad, Franklin and Marshall College.

LANSDOWNE.

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LEBANON.

Hayes, George W.
Weimer, Edgar A., Weimer Machine Works Company.

LEMONT.

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LEWISBURG.

Owens, William Gundy, Bucknell University.

LINCOLN UNIVERSITY.

Miller, J. Craig.
Wright, Walter Livingston, Jr.

LITITZ.

McLean, Charlotte F., Linden Hall.

LOCK HAVEN.

Allabach, Miss Lulu F., Central State Normal School.
Flickinger, Junius R., Normal School.
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MEDIA.

Hoopes, H. E.

MEADVILLE.

Breed, Robert S., Allegheny College.
Montgomery, James H.
Wells, H. Edward, Alleghany College.

MECHANICSBURG.

Strong, William Walker.

MILFORD.

Doughty, Mrs. Alla.

MILLERSVILLE.

Bitner, Henry F., First Pa. State Normal School.

MINERSVILLE.

Spayd, Henry Howard.

MONONGAHELA.

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MOUNT JOY.

Zeigler, J. L.

MUNHALL.

Dinkey, Alva C.

MURRYSVILLE.

Stewart, Francis L.

New Wilmington.

Freeman, Charles, Westminster College.
Shott, John A., Westminster College.

Oakmont.

Barnsley, George Thomas.

Oil City.

Babcock, Charles A.
Oliphant, F. H., South Penn. Oil Co.

Philadelphia.

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Ashbrook, Donald Sinclair, 3614 Baring Street.
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Goodwin, Harold, 3927 Locust Street.
Gould, George Milbray, 1722 Walnut Street.
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Jayne, Harry W., 931 N. Broad Street.
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Kraemer, Henry, 145 North 10th Street.
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Lazell, Ellis W., 1619 Filbert Street.
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LeConte, Robert Grier, 1625 Spruce Street.
Lee, Benjamin, 1420 Chestnut Street.
Lee, Waldemar, 4620 Wayne Street.
Leeds, Morris E., 3221 North 17th Street.
Leidy, Joseph, Jr., 1319 Locust Street.
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Longstreet, Morris, 1416 Spruce Street.
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Lyman, Benjamin Smith, 708 Locust Street.
MacAlister, James, Drexel Institute.
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Maignen, Prosper Auguste, 1310 Arch Street.
Makuen, G. Hudson, 1627 Walnut Street.

Marks, William D., "The Art Club."
Mebus, Charles F 908–909 Land Title Bldg.
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Peirce, Harold, 222 Drexel Building.
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Pennypacker, James Lane, 614 Arch Street.
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Potts, Howard Newcomb, 466 North 7th Street.
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Reed, Charles J., 3313 North 16th Street.
Reckefus, Chas. H., Jr., 506 North 6th Street.
Remington, Joseph Price, 1832 Pine Street.
Richardson, Leon B., 3443 Chestnut Street.
Richtmyer, F. K., 23 South 53d Street.
Riesman, David, 1624 Spruce Street.
Ritchie, Craig D., 414 North 34th Street.
Rorer, Jonathan T., Central High School.
Rothermel, John G., Wagner Free Inst. of Science.

Rotzell, W. E., 200 S. 40th Street.
Sadtler, Samuel P., N.E. corner 10th & Chestnut Streets.
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Smith, Edgar F., University of Pennsylvania.
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Smith, S. MacCuen, 1700 Walnut Street.
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Warder, Charles Barclay, 1715 Walnut Street.
Wardle, Harriet N., 125 North 10th Street.
Welsh, Francis Ralston, 328 Chestnut Street.
Wenner, Frank, University of Penna.
Wetherill, H. Emerson, 3734 Walnut Street.
Whitfield, J. Edward, 406 Locust Street.
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Witmer, Lightner, University of Pennsylvania.
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Wood, R. Francis, 410 S. 15th Street.
Wood, Stewart, 400 Chestnut Street.

Wood, Walter, 400 Chestnut Street.
Woodbury, Frank, 218 South 16th Street.

PHOENIXVILLE.

Deans, John S., Phoenix Bridge Company.

PITCAIRN.

Beatty, James W. F.

PITTSBURG.

Anderson, J. Hartley, 4630 5th Avenue.
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Baggaley, Ralph.
Bland, John C., 1003 Penn Avenue.
Browne, W. R., Bureau of Surveys.
Buchanan, James I., Conestoga Building.
Crawford, David Francis, Union Station.
Daggette, Alvin S., 400 South Craig Street.
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Ely, Sumner B., Vandergrift Building.
English, William Thompson, Western University of Pennsylvania.
Falconer, William, Allegheny Cemetery.
Finley, Norval H., 7229 Hermitage Street.
Fisher, Henry Wright, S. U. Cable Company.
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Hartman, C. V., Carnegie Museum.
Holland, W. J., Carnegie Museum.
Hopkins, Anderson Hoyt, Carnegie Library.
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Kahl, Paul H. I., Carnegie Museum.
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Litchfield, Lawrence, 5431 Fifth Avenue.
Macbeth, George A., 717 Amberson Avenue.
McClelland, James H., 5th and Wilkins Avenues.
Macfarlane, James R., Court House.
McKelvy, William H., 420 6th Avenue.
Mellor, Charles C., 319 5th Avenue.
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Metcalf, William, 1 Fulton Street.
Morrison, Thomas, Diamond Bank Building.

Nicola, Frank F., Farmers' Bank Building.
Ortmann, Arnold E., Carnegie Museum.
Osborne, Loyall Allen, Westinghouse Electric and Mfg. Company.
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Reed, James H., Amberson Avenue.
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Scaife, William L., 28th Street.
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Pittston.

Berry, John Wilson.

Plymouth.

Woren, Christopher.

Pottsville.

Sheafer, A. W.

Reading.

Bryson, Andrew, Brylgon Foundry.
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Mengel, Levi W., Boys' High School.

Ridgway.

Williams, J. C., Orchard Street.

Rockland.

Taylor, J. Erskine.

Rosemont.

Johnson, Alba B.

Scranton.

Clark, John Jesse, International Text Book Co.
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SHARPSVILLE.

West, Thomas Dyson, T. D. West Engraving Co.

SHEFFIELD.

Horton, Byron Barnes.

SMETHPORT.

Scull, Miss Sarah A.

SOUTH BETHLEHEM.

Cleaver, Albert M.
Davis, Wm. Harper, Lehigh University.
Franklin, William S., Lehigh University.
Frazier, B. W., Lehigh University.
Hall, Robert William, Lehigh University.
Irving, John Duer.
Loewenstein, Louis C., Lehigh University.
MacNutt, Barry, Lehigh University.
Merriman, Mansfield, Lehigh University.
Sayre, Robert H.
Schober, Wm. Bush, Lehigh University.
Sullivan, Lucien Norris, Lehigh University.
Thornburg, Charles L., Lehigh University.
Ullmann, H. M., Lehigh University.

STATE COLLEGE.

Armsby, Henry Prentiss.
Buckhout, W. A.
Clark, Friend E.
Frear, William.
Osmond, I. Thornton.
Pond, G. Gilbert.
Surface, H. A.
Wadsworth, M. Edw.
Wood, Arthur J.

SWARTHMORE.

Alleman, Gellert, Swarthmore College.
Cunningham, Susan J., Swarthmore College.
Hoadley, George A., Swarthmore College.
Stine, W. M., Swarthmore College.
Swain, Joseph.

UNIONTOWN.

Lemley, C. McC., Second National Bank Bldg.

UPPER DARBY.

Doolittle, C. L.

VANDERGRIFT.

Pinkerton, Andrew.

VILLA NOVA.

Morris, F. W.

WARREN.

Guth, Morris S., Milwaukee County Hospital.
Jefferson, J. P.
Lindsey, Edward.
Quinn, John James

WALTERS' PARK.

Walter, Robert.

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McAdam, D. J., Washington and Jefferson College.

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WEST FAIRVIEW.

Bashore, Harvey B.

WILKENSBURG.

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Westinghouse, Henry Herman.

WYNCOTE.

Crawley, Howard.
Crawley, Joseph Sanford.

YORK.

Ehrenfeld, Charles Hatch, Collegiate Institute.
Wanner, Atreus.

PHILIPPINE ISLANDS.

Bagino.

Thomas, Jerome B., Benguet.

Cavite.

Winterhalter, A. G., Naval Station.

Manila.

Copeland, Edwin Bingham, Bureau of Gov't Laboratories.
Folkmar, Daniel, care Civil Service.
Jenks, Albert E., Chief of Ethnological Survey.
Mearns, Edgar A.
Merrill, Elmer D., Bureau of Government Laboratories.
Whitford, Henry Nichols, Bureau of Government Laboratories.
Worcester, Dean C., U. S. Philippine Commission.

RHODE ISLAND.

Kingston.

Barlow, John, R. C. College A. and M. Arts.
Card, Fred. W., College of Agriculture.
Merrow, Miss Harriet L., College of Agriculture.
Wheeler, Homer J., R. I. Exper. Sta.

Matunuck.

Matlack, Charles, "Hidden Hearth."

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Gibbs, Wolcott.
Tiffany, Lyman, 123 Pelham Street.
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Peace Dale.

Hazard, Rowland G.

Providence.

Appleton, John Howard, Brown University.
d'Auria, Luigi, care Builders' Iron Foundry.
Barus, Carl, Wilson Hall, Brown University.
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Woonsocket.

Marble, Miss Sarah.

SOUTH CAROLINA.

Aiken.

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Ashley, George H., College of Charleston.
Parker, Francis L., College of Charleston.
Rea, Paul M., College of Charleston.

Clemson College.

Brackett, Richard N.
Brodie, Paul T.
Calhoun, Fred H. H.
Chambliss, Charles E.
Earle, Samuel Broadus.
McDonnell, Curtis C.
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Metcalf, Haven.
Poats, T. G.

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SOUTH DAKOTA.

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Britton.

Jewett, Geo. Franklin.

Brookings.

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McLaury, Howard L., School of Mines.
O'Hara, Cleophas Cisney, School of Mines.
Slagle, Robert Lincoln, School of Mines.

Rosebud.

Scovel, Edward C.

Sioux Falls.

Peabody, Mary Brown, All Saints School.

Vermillion.

Akeley, Lewis E., State University.
Droppers, Garrett, State University.
Todd, James E., State University.

Yankton.

Harvey, LeRoy Harris, Yankton College.

TENNESSEE.

Bristol.

Williams, Harvey Ladew, P. O. Box 410.

CHATTANOOGA.

Anderson, Edwin Clinton, 726 Market Street.
Brierly, H. E., Grant University.

GLASS.

Brown, Calvin S.

KNOXVILLE.

Ayres, Brown, University of Tenn.
Bain, Samuel M., University of Tennessee.
Claxton, P. P., University of Tennessee.
Essary, Samuel Henry, University of Tennessee.
Fulton, Weston Miller, University of Tennessee.
Morgan, H. A., Agric. Exper. Sta.
Perkins, Charles Albert, University of Tennessee.
Wait, Charles E., University of Tennessee.

LEBANON.

Waterhouse, James Smartt, Cumberland University.

MARYVILLE.

Kennedy, Mary E., Maryville College.

MEMPHIS.

Cook, James B., Randolph Building.
Sinclair, Alexander Grant, Memphis Hospital Medical College.

NASHVILLE.

Brown, Lucius Polk, 310 Union Street.
Daniel, John, Vanderbilt University.
Dudley, William L., Vanderbilt University.
Glenn, L. C., Vanderbilt University.
Hollinshead, Warren H., Vanderbilt University.
Lund, Robert Leathan.
McGill, John T., Vanderbilt University.
Martin, George W., Vanderbilt University.
Thruston, Gates Phillips.
Waterman, Warren Gookin, Fisk University.

SEWANEE.

Barton, Samuel M., University of the South.
Hall, William Bonnell, University of the South.

TEXAS.

AUSTIN.

Bray, William L., University of Texas.
Ellis, A. Caswell, University of Texas.
Ferguson, Alexander McGowen, University of Texas.
Harper, Henry Winston, 2208 San Antonio Street.

Lowber, James William, 113 East 18th Street.
Mezes, Sidney Edward, University of Texas.
Pearce, James Edwin, 309 West 10th Street.
Rucker, Miss Augusta, University of Texas.
Simonds, Frederic W., University of Texas.
Smith, Matthew Mann.
Smith, Q. Cincinnatus, 617 Colorado Street.

BELTON.

Wells, Eliab Horatio, Baylor Female College.

COLLEGE STATION.

Fraps, George Stronach.
Nagle, James C., Agricultural and Mechanical College.
Ness, Hege, Agricultural and Mechanical College.
Puryear, Chas., Agricultural and Mechanical College.
Tilson, P. S., Agricultural and Mechanical College.

COLUMBUS.

Harrison, Robert Henry.

CORPUS CHRISTI.

Spohn, Arthur Edward.

DALLAS.

Hasie, Montague S., Texas Bridge Co.
Smith, J. F., Commercial College.

DENISON.

Munson, T. V.

DENTON.

Long, William H., Jr.

EL PASO.

Mellish, Ernest Johnson.

FORT WORTH.

Boon, John Daniel, Polytechnic College.
Chase, Ira Carleton.
Curtis, George W.

GALVESTON.

Patten, Frank Chauncy, Rosenberg Library.
Thompson, James Edwin, 3224 Broadway.

GARRISON.

Mally, Frederick W.

HEMPSTEAD.

Montgomery, Edmund.

HILLSBORO.

Thompson, Benj., T. & B. V. Ry. Co.

Houston.

Dumble, E. T., 1306 Main Street.
McLaughlin, A. C., Houston Oil Co., of Texas.

Huntsville.

Coleman, Walter, Sam Houston Normal Institute.
Halley, Robert Burns, Sam Houston Normal Institute.

Orange.

Saunders, James, Lock Box 147.

Prairie View.

Blackshear, Edward Levoisier.

San Antonio.

Brackenridge, George W.
Braunnagel, Jules L. A., P. O. Box 925.

Texarkana.

Sheppard, Morris.

Victoria.

Crouse, Hugh Woodward.

Waco.

Cole, W. F.
Kesler, John Louis, Baylor University.

Wolfe City.

Holstein, George W.

Yoakum.

Shropshire, Walter.

UTAH.

Logan.

Ball, Elmer D., Agricultural College.
Kerr, Wm. J., Agricultural College.
Linford, James Henry, The Brigham Young College.

Salt Lake City.

Anderson, Frank, 255 2d East Street.
Ebaugh, W. Clarence, University of Utah.
Ellis, Henry Rives, 217 South West Temple Street.
Fisher, Robert Welles, 159 East 2d South Street.
Garrett, Albert O., 615 South Ninth East Street.
Howard, Orson, University of Utah.
Jenney, Walter Proctor, Knutsford Hotel.
Jones, Marcus E.
Larrabee, Austin P., Salt Lake High School.
Merrill, Joseph Francis, University of Utah.
Reynolds, George, P. O. Box B.
Talmage, James Edward, University of Utah.
Tiernan, Austin K., University Club.

Woods Cross.

Pack, Fred J.

VERMONT.

Brattleboro.

Holton, Henry D.

Bristol.

Dike, Archie Clarence.

Burlington.

Brett, George Monroe, University of Vermont.
Butterfield, Arthur Dexter, University of Vermont.
Freedman, William Horatio, University of Vermont.
Jones, Lewis Ralph, University of Vermont.
Morse, Warner Jackson, University of Vermont.
Perkins, George H.
Perkins, Henry F., University of Vermont.
Stuart, William, University of Vermont.
Taft, Elihu B.
Votey, J. William, University of Vermont.

Enosburg Falls.

Towle, William Mason.

Jericho.

Bentley, Wilson A.

Johnson.

Ham, Judson B., State Normal School.

Middlebury.

Burt, Edward Angus, Middlebury College.

Rutland.

Francisco, M. Judson, 49 Merchants' Row.

Saint Johnsbury.

Fairbanks, Henry.

Springfield.

Hartness, James, Jones & Lamson Machine Company.

VIRGINIA.

Alexandria.

O'Brien, Matthew Watson, 908 Cameron Street.

Ashland.

Canter Hall, Randolph-Macon College.

Big Stone Gap.

Hodge, James M.

Blacksburg.

Davidson, R. J. Agric. Exper. Station.
Phillips, John Lloyd, State Entomologist.
Price, Harvey Lee, Agricultural Experiment Station.

Blackstone.

Fishburne, Edward B., Jr.

Bluemont.

Humphreys, W. J., Mt. Weather.
Thiessen, Alfred Henry, Mt. Weather.

Charlottesville.

Alwood, Wm. B.
Dunnington, F. P., University of Virginia.
Jones, Ernest S., University of Virginia.
Mallett, J. W., University of Virginia.
Smith, Francis Henry.
Stone, Ormond, University of Virginia.
Thornton, William M., University of Virginia.
Tuttle, Albert H., University of Virginia.

College Park.

Hamaker, John Irvin, Randolph-Macon Women's College.
Martin, F. W., Randolph-Macon Women's College.

Covesville.

Robinson, Samuel Adams.

Crewe.

Weems, J. B.

Emory.

Miller, James Shannon, Emory and Henry College.

Farmville.

Jarman, Joseph L., State Female Normal School.

Fredericksburg.

Richardson, William D., P. O. Box 185.

Hampden-Sidney.

Bagby, J. H. C., Hampden-Sidney College.

Hollins.

Duke, Frank Williamson, Hollins Institute.

Lexington.

Campbell, Henry Donald, Washington and Lee University.
Howe, James Lewis, Washington and Lee University.
Humphreys, David Carlisle, Washington and Lee University.
Stevens, W. LeConte, Washington and Lee University.

Long's Shop.

Price, Robert Henderson, Willow View Farm.

Miller School.

Tompkins, Stonewall.

Newport News.

Hopkins, Albert L., 2904 West Avenue.
Post, Walter A., Newport News Shipbuilding and Drydock Co.

Richmond.

Garcin, Ramond D., 2618 East Broad Street.
Hunter, J. Rufus, Richmond College.
Johnston, Geo. Ben., 407 East Grace Street.
Kimball, James H., Weather Bureau.
Levy, Ernest C., 615 East Franklin Street.
Magruder, Egbert W., Department of Agriculture.
Valentine, Edward P.

Roanoke.

Engle, Horace M.

Saltville.

Mount, William D., Mathieson Alkali Works.

Theological Seminary.

Hoxton, Llewellyn Griffith.

WASHINGTON.

Dayton.

Pietrzycki, Marcel.

Mora.

Reagan, Albert B.

Mount Vernon.

Waugh, James Church.

Port Townsend.

Wyckoff, Ambrose B., U. S. N.

Pullman.

Bryan, Enoch, State College.
Shedd, Solon.

Seattle.

Brainerd, Erastus.
Eagleson, James B., 512 Burke Building.
Frye, Theodore Christian, State University.
Landes, Henry.
Magnusson, Carl Edward, University of Washington.
Millis, John, U. S. Engineer's Office.
Osborn, Frederick A., University of Washington.
Roberts, Milnor, University of Washington.
Shelton, Edward M., 2904 Franklin Avenue.

Spokane.

Burbidge, Frederick, 510 Empire State Building.
McMullen, Joseph F., 1908 Nora Avenue.

Tacoma.

Gault, Franklin B., 602 North I Street.
Hawxhurst, Robert, Jr., 620 North C Street.
Smith, Alice Maude, 327 North G Street.

WEST VIRGINIA.

Berkeley Springs.

Randolph, Beverley S.

Charleston.

Cargill, George W.

Charles Town.

Wendling, Geo. R.

Clarksburg.

Smith, Harvey F.

Gauley Bridge.

Sharp, Charles Cutler.

McMachen.

Covert, William Ross.

Martinsburg.

McCune, M. Virginia, 506 West John Street.

Morgantown.

Brock, Luther S.
Brown, Samuel B.
Fast, Richard Ellsworth, West Virginia University.
Grimsley, George Perry.
Hennen, Ray V., L. B. 448.
Johnson, Thomas Carskadon, Agricultural Experiment Station.
Johnston, John Black, West Virginia University.
Jones, Clement Ross, West Virginia University.

Maxwell, Hu.
Morris, Russell Love, West Virginia University.
Sheldon, John Lewis, Agricultural Experiment Station.
Stewart, James H., Agricultural Experiment Station.
White, I. C.
Whitham, William Henry, West Virginia University.

PHILIPPI.

Six, William Lewis.

WAVERLY.

Brooks, Earle Amos.

WHEELING.

Crockard, Frank Hearne, Lock Box 34.

WISCONSIN.

BELOIT.

Smith, Erastus G., Beloit Sanitary Laboratory.
Smith, Thomas A., Beloit College.

CHIPPEWA FALLS.

Ascham, Louis, 420 W. Willow Street.

FOND DU LAC.

Molitor, David, 125 Park Avenue.

GREEN BAY.

Schuette, J. H.

KENOSHA.

Windesheim, Gustave, 255 Main Street.

MADISON.

Allen, Bennet Mills, University of Wisconsin.
Babcock, S. Moulton, 432 Lake Street.
Bardeen, Charles Russell, University of Wisconsin.
Birge, Edward A., University of Wisconsin.
Bull, Storm, University of Wisconsin.
Comstock, George C., University of Wisconsin.
Fenneman, Nevin M., University of Wisconsin.
Flint, Albert S., Washburn Observatory.
Frost, William Dodge, University of Wisconsin.
Fuller, Caleb Allen, Hygienic Laboratory.
Hanks, M. W., 216 Langdon Street.
Harper, R. A.
Hastings, Edwin George, Agricultural Experiment Station.

Hillyer, Homer W., University of Wisconsin.
Hobbs, William Herbert.
Hunt, Caroline L., University of Wisconsin.
Jastrow, Joseph, University of Wisconsin.
Kahlenberg, Louis, University of Wisconsin.
King, F. H., University of Wisconsin.
Knapp, G. N., College of Agriculture.
Kremers, Edward, University of Wisconsin.
Leith, Charles Kenneth, University of Wisconsin.
Lenher, Victor, University of Wisconsin.
Maurer, Edward R., University of Wisconsin.
Mendenhall, Charles E., University of Wisconsin.
Miller, Louallen F., University of Wisconsin.
Miller, William S., University of Wisconsin.
Olive, Edgar W.
O'Shea, M. V., University of Wisconsin.
Overton, James Bertram, University of Wisconsin.
Russell, H. L., University of Wisconsin.
Sandsten, E. P., University of Wisconsin.
Slichter, Charles S., University of Wisconsin.
Snow, Benjamin W., 518 Wisconsin Avenue.
Trowbridge, Augustus, University of Wisconsin.
Turneaure, Frederic E., University of Wisconsin.
Van Hise, Charles R., University of Wisconsin.
Wagner, George, University of Wisconsin.
Weidman, Samuel, Wisconsin State Geological and Natural History Survey.
Wetzel, Reinhard A., University of Wisconsin.
Woll, Fritz Wilhelm, 424 Charter Street.

Menomonie.

Davis, Kary Cadmus.

Milton.

Daland, William Clifton.

Milwaukee.

Beach, William Harrison, 229 Pleasant Street.
Barnes, C. T., Public Museum.
Case, Ermine Cowles, State Normal School.
Conway, George M., 10 Belvedere.
Friend, Samuel Henry, 141 Wisconsin Street.
Kletzsch, Gustav A., 453 Cass Street.
Mitchell, Andrew S., 220 Greenbush Street.
Neilson, Walter Hopper, 114 Garfield Avenue.
Nolte, Lewis G., Senn's Block.
Ogden, Henry Vining, 141 Wisconsin Street.

Sands, Will J., care Allis Chalmers Co.
Sherman, Lewis, 448 Jackson Street.
Stickney, Gardner P., Wisconsin Trust Co.
Uihlein, August, 332 Galena Street.
Ward, Henry L., Public Museum.

OCONOMOWOC.

Voje, John Henry, Private Sanatorium, Waldheim.

RACINE.

Davis, J. J., 1119 College Avenue.

RIPON.

Chandler, Charles Henry.

STEVENS POINT.

Culver, Garry Eugene, 1103 Maine Street.

WAUWATOSA.

Grosskopf, Ernest C., Milwaukee County Hospital.

WILLIAMS BAY.

Barnard, Edward E., Yerkes Observatory.
Fox, Philip, Yerkes Observatory.
Frost, Edwin Brant, Yerkes Observatory.
Reese, Herbert M., Yerkes Observatory.
Schlesinger, Frank, Yerkes Observatory.
Wallace, Robert James, Yerkes Observatory.

WYOMING.

BUFFALO.

Onderdonk, Henry U.

CHEYENNE.

Morris, Robert C., Clerk of Wyoming Supreme Court.

FOUR BEAR.

Pickett, William Douglas.

LARAMIE.

Buffum, Burt C.
Nelson, Aven, University of Wyoming.

RAWLINS.

Carter, James.

SHERIDAN.

Coffeen, H. A.

SHOSHONE AGENCY

Ramsey, Miss Mary C.

FOREIGN.

BRAZIL.

Ouro Preto.

da Costa Sena, Joaquim Candido, School of Mines.

Sao Paulo.

Derby, Orville A.
Lane, Horace Manley, Caixa 14.
von Ihering, F., Museu Paulista.

BRITISH COLUMBIA.

Rossland.

Thompson, William, Rossland Great Western Mines, Limited.

Victoria.

Sutton, William J.

Winnipeg.

Allen, Frank, Univ. of Manitoba.

CANADA.

Acton Vale.

Würtele, John Hunter.
Würtele, Louis C.

Barrie.

Hunter, Andrew Frederick.

Chatham.

Macfarlane, A., Victoria Avenue.

Dawson.

Tyrrell, Joseph B.

Guelph.

Mills, James, Ontario Agricultural College.
Sherman, Franklin, Jr., Ontario Agric. College.

Halifax.

Murray, Daniel A., Dalhousie College.

Kingston.

Brock, Reginald Walter, School of Mining.

Lindsay.

Cornish, George A.

London.

Bethune, C. J. S., 500 Dufferin Avenue.

MONTREAL.

Burgess, Thomas J. W., Protestant Hospital for the Insane.
Butler, Matthew J., 877 Dorchester Street.
Holt, Herbert S., Montreal Light, Heat and Power Company.
Iles, George, 5 Brunswick Street.
Lampard, Henry, 102 Shuter Street.
Lochhead, William, Macdonald College.
Loeb, Leo, McGill University.
Lyman, Henry H., 74 McTavish Street.
Mills, Wesley, McGill University.
Penhallow, David Pearse, McGill University.
Schenck, Charles C., McGill University.
Walls, John Abbet, 1724 Notre Dame Street.

NIAGARA FALLS.

Converse, Vernon G., Ontario Power Co.

OTTAWA.

Ami, H. M., Geological Survey.
Bell, Robert, Geological Survey.
Dawson, William Bell, Marine Department.
Fletcher, James, Experimental Farm.
Klotz, Otto Julius, 437 Albert Street.
Saunders, Charles E., Experimental Farm.
Saunders, William, Experimental Farm.
Shutt, Frank T., Experimental Farm.
Whiteaves, J. F., Geological Survey.

QUEBEC.

Archibald, Raymond Clare, Sackville.
Laflamme, J. C. K., Laval University.

STANSTEAD.

Moore, Mrs. A. H.

TORONTO.

Burton, E. F., Toronto University.
Chant, Clarence Augustus, University of Toronto.
Clark, Judson F., 164 Davenport Road.
Faull, Mrs. Annie B. Sargent, 245 McCaul Street.
Faull, Joseph Horace, University of Toronto.
Galbraith, John, School of Practical Science.
James, Charles C., Department of Agriculture.
Kammerer, Jacob Andrae, 87 Jameson Avenue.
Kirschmann, A., Toronto University.
McLennan, John C., Toronto University.
Montgomery, Henry, Trinity College.
Walker, Byron Edmund.

CHINA.

Amoy.

Rathbun, John Charles, Tung Wen Institute.

COSTA RICA, C. A.

San Jose.

Keith, John Meiggs.

CUBA.

Santiago.

Austin, C. F., Estacion Central Agronomica de Cuba.
Baker, Carl F., Estacion Central Agronomica de Cuba.
Cook, Melville T.
Earle, F. S.
Halstead, Ernest W.

ENGLAND.

Cambridge.

Russell, Henry Norris, The Observatory.

Lampeter.

Scott, Arthur William, St. David's College.

London.

Hoover, Herbert C., care Bewick, Moreing & Co., Broad Street House, New Broad Street.
Hoover, Mrs. Lou Henry, care Bewick, Moreing & Co., Broad Street House, New Broad Street.
Power, Frederick B., 6 King Street, Snow Hill, E. C.
Wells, Wm. H., Jr., 2 Norfolk Street, Strand, W. C.

Oxford.

Myres, John L., Christ Church.

Rothamsted.

Warington, Robert.

FRANCE.

Menton.

Allis, Edward Phelps, Jr., Palais Carnolès.

Paris.

Cathcart, Miss J. R., care Munroe & Co., 7 rue Scribe.
Loubat, Le Duc De, 47 rue Dumont d'Urville.

GERMANY.

Berlin.

Hoffmann, Friedrich, Charlottenburg, Kant Street 125.
Tuckerman, Louis Bryant, Jr., Krausnickstr., 22.

Frankfort.

Hartmann-Kempf, Robert A.

HUNGARY.

Budapest.

Krécsy, Béla, vi Bulyovsxky u. 22.

ITALY.

San Remo.

Kuntze, Otto, Villa Girola.

JAMAICA, B. W. I.

Kingston.

Fawcett, Wm., Hope Gardens.

JAPAN.

Kioto.

Miyake, Kiichi, Doshisha College.

Kobe.

Hoyt, Olive Sawyer, Kobe College.

Tokyo.

Loew, Oscar.

Yokohama.

Gause, Fred. Taylor.

MEXICO.

Aguascalientes.

Morse, Willard S.
Altamirano, Fernando, Instituto Medico Nacional.

Cedral.

Alexander, Curtis.

City of Mexico.

Aguilera, José G., Ecological Institute of Mexico.
Hall, Charles E., care Hoffman, Pinther & Co., 3 Independence 10.
Hard, James M. B., Cordobanes 16.

COLIMA.

Herbert, Arthur P.

COYOACAN, D. F.

Nuttall, Mrs. Zelia, Casa Alvarado.

FUERTE, SINALOA.

Tays, Eugene Aug. Hoffman.

GUADALAJARA.

Schiaffino, Mariano L.

MACONI, DISTRITO DE CADEREYTA, ESTADO DE QUERETARO.

Schiertz, Ferdinand Alfred.

MATCHUALA, S. L. P.

Wentworth, Irving H.

MONCLOVA.

Cerna, David.

MONTEREY.

Dysterud, E.

OAXACA.

Jeffrey, Robert Henry, Apartado 104.

PACHUCA.

De Landero, Carlos F.

SALTILLO.

Abbott, Theodore Sperry.

TACUBAYA.

Valle, Felipe.

TORRES.

Peterson, Bertel.

VILLA CORONA.

Carnaghan, Edwin D.

NEW ZEALAND.

MANAWATER.

Frankland, Frederick W., Herston Farm, Foxton

NICARAGUA.

BLUEFIELDS.

Le Baron, J. Francis, care Señor Adolf Diaz.

NOVA SCOTIA.

BADDECK.

McCurdy, Arthur W.

SAMOA.

Tutuila.

Frederick, Charles Warnock.

SICILY.

Catania.

Scaife, Walter B., care A. W. Elford.

SOUTH AFRICA.

Cape Town.

Beattie, J. C., South African College.
Gilchrist, John D., Department of Agriculture.
Lounsbury, Charles P., Department of Agriculture.
Mally, Charles William, Department of Agriculture.

Pretoria.

Davy, J. Burtt, Department of Agriculture.
Simpson, Charles Baird, Department of Agriculture.

SWITZERLAND.

Zurich.

Field, Herbert Haviland, Eidmattstrasse, 38.
Scripture, E. W., Phonetic Laboratory, Registr., 47.

TURKEY.

Harput.

Norton, Thomas H., United States Consulate.

WESTERN AFRICA.

Nigeria.

McDermott, P. A., Roman Catholic Mission, Old Calabau.

DECEASED MEMBERS.

[A list of deceased members of the Association, so far as known at the time of publishing the volume of Proceedings of the Springfield meeting, May, 1896, is given in that volume. At the Buffalo meeting the Council directed the Permanent Secretary to omit the printing of the full list of deceased members in the annual volumes and to print only the additions to the list. Since the publication of the list printed in the Washington Proceedings (Vol. 52) notices have been received of the decease of the following members.]

ABBOT, SAMUEL L., 90 Mt. Vernon St., Boston, Mass. (1). Died July 1, 1904.

Alvord, Henry E., U. S. Dept. Agriculture, Washington, D. C. (29). Died October 1, 1904.

Anderson, James Thomas, Colorado Springs, Colo. (51). Died May —, 1904.

Anthony, Mrs. Emilio C., Gouverneur, N. Y. (47). Died March 17, 1904.

AVERY, SAMUEL P., 4 E. 38th Street, New York, N. Y. (36). Born March 17, 1822. Died August 11, 1904.

Avis, Capt. Edw. S., Dahlonega, Ga. (52). Died April 2, 1904.

Bancroft, Alonzo C., Elma, N. Y. (41).

Bartlett, John R., Lonsdale, R. I. (30).

Bell, Alex. Melville, Washington, D. C. (31).

Bonscaron, Louis F. G., City Hall, Cincinnati, Ohio. (50). Died November —, 1904.

Bowman, Joseph H., Cordoba, Mexico. (50).

Brace, D. B., Univ. of Nebraska, Lincoln, Neb. (48).

Canby, Wm. M., 1101 Delaware Ave., Wilmington, Del.

Chrystie, Wm. F., Hastings-on-Hudson, N. Y. (36). Died December 3, 1902.

Colgate, Abner W., Morristown, N. J. (44).

Davis, Nathan Smith, 65 Randolph St., Chicago, Ill. (51). Died June —, 1904.

de Peyster, Johnston Livingston, Tivoli, N. Y. (52). Died May 27, 1903.

Drown, Thomas M., Lehigh University, South Bethlehem, Pa. (29). Died November 16, 1905.

Du Pont, Francis G., Montclair, Del. (33). Died November —, 1904.

Foster, George Winslow, Eastern Maine Insane Asylum, Bangor, Maine. (52).

Gardner, C. Clinton, 416 Beach St., N., Richmond Hill, New York. (50). Died August 12, 1904.

Greeley, Arthur White, Washington University, St. Louis, Mo. (53).

Harmon, Miss A. Maria, 171 MacLaren St., Ottawa, Canada. (31). Died September 19, 1904.

Hatcher, John Bell, Carnegie Museum, Pittsburg, Pa. (50). Died July 3, 1904.

Hendricks, Henry H., 49 Cliff St., New York, N. Y. (30).

Hungerford, W. S., Jersey City, N. J. (43). Died June 19, 1904.

Keene, George Frederick, State Hospital for Insane, Howard, R. I. (51). Died March 13, 1905.

Kirk, Arthur, 910 Duquesne Way, Pittsburg, Pa. (50). Died September 26, 1904.

Klingensmith, Israel P., Blairsville, Pa. (51). Died September 27, 1904.

Lanphear, Burton S., Iowa State College, Ames, Iowa. (51). Died October 14, 1904.

Leiter, L. Z., Dupont Circle, Washington, D. C. (40).

Lemp, Wm. J., Cherokee and Second Carondelet Ave., St Louis, Mo.

McCalley, Henry, University, Ala. (50). Died November 21, 1904.

Montgomery, James H., Meadville, Pa. (50). Died August 11, 1904.

Packard, A. S., 115 Angell St., Providence, R. I. (16).

Palmer, Arthur William, 804 Green St., Urbana, Ill. (46).

Pell, Mrs. Alfred, Highland Falls, N. Y. (51). Died November 30, 1904.

Pettee, Wm. H., University of Michigan, Ann Arbor, Mich. (24). Died May 26, 1904.

Pierce, Perry Benjamin, U. S. Patent Office, Washington, D. C. (40).

Prather, Wm. L., University of Texas, Austin, Texas. (50).

Prescott, Albert B., University of Michigan, Ann Arbor, Mich. (23).

Pulsifer, Wm. H., Nonquith, Mass. (26). Died April 9, 1905.

Quintard, Edward A., Sewanee, Tenn. (50). Died April 6, 1903.

Rockwell, Alfred P., Manchester, Mass. (10). Died December 24, 1903.

Rockwood, Charles G., 70 S. 11th St., Newark, N. J. (36).

Stieringer, Luther, 129 Greenwich St., New York, N.Y. (50). Died July 17, 1903.

Sullivan, J. A., 31 Massachusetts Ave., Boston, Mass. (27). Died July 13, 1905.

Upton, George B., Milton, Mass. (50). Died February 7, 1904.

Walpole, Frederick A., U. S. Dept. Agriculture, Washington, D. C. (52).

ADDRESS

BY

THE RETIRING PRESIDENT OF THE ASSOCIATION.

ADDRESS

BY

CARROLL D. WRIGHT,

THE RETIRING PRESIDENT OF THE ASSOCIATION.

SCIENCE AND ECONOMICS.

In science we find the dynamics of political economy, as well as many other branches of human knowledge and human speculation. That eminent prelate and statesman, James Cardinal Gibbons, at the dedication of McMahon Hall of Philosophy at the Catholic University of America a few years ago, said that many were of the opinion that the Mother Church did not welcome the results of scientific research—that there might be something to be feared relative to theology and religion in such research—but he asserted emphatically that the church welcomed all science and all revelations of science as new revelations of religion. His eminence recognized and appreciated the great changes in thought which had come over the world of intelligence during the last thirty or forty years, and that nothing could be revealed by science that did not reveal the hand of the great first cause; that science was God's instrument in teaching His handiwork to the human race.

The conflicts of science and religion, about which we heard so much a generation ago, have no place now in the thought of those who see in science such handiwork. We no longer look upon the earth as the spasmodic creation of a few days. Genesis becomes grand and beautiful poetry in place of alleged history. We see in it the traditions of primitive man in his attempt to account for creation. We see the economic development and evolution that brought into existence, through the

slow steps necessary to produce it, what we recognize as the earth; and we appreciate more and more that this is to the greater glory of the first great cause than that formerly assumed method, the result of a literal reading of Genesis.

Science is no longer a menace to religion. It has, to be sure, overturned dogmas, upset superstitions, and changed the theological thought of the world, but it has left with us the evidence of that divine economy in creation which is so essential in considering the works of the Almighty; and as the result of increased knowledge which science has brought us the human race is happier, and more generally recognizes that all things must grow slowly, steadily, surely to that stage of perfection which must mark the works of the Supreme Architect.

If this has been the result in the realms of theology, so long ruled by dogma and artificial tenets, science must have had some influence in shaping those matters which belong to the every-day life of man, his business relations, and his social environment. For the present hour I am to consider what this influence has been in overturning, modifying, and extending the theories of economists, and see whether political economy owes anything to science, or what science must and can do in reshaping and extending the great laws of the business world.

First, we must consider that peculiar and interesting doctrine known as Malthusianism. The doctrines set forth by Malthus comprehended more than his celebrated theory relative to the encroachments of population upon the food supply. These supplemental doctrines involved what is popularly known as the iron law of wages, the wages fund, and the law of diminishing returns, all of which have by scientific thought and investigation given way in large degree to theories more rational and more in line with the facts.

Concretely, Malthus announced the theory that population increased in a geometrical and food in an arithmetical ratio, but after the announcement he contented himself with a more general proposition that population, unless checked by war, poverty, and other calamities, tended to increase faster than sustenance. Malthus was supported by other writers. There is, of course, something in this doctrine relative to the pressure

of population upon the food supply which must be admitted as containing some truth, and at the time Malthus wrote it was supposed to contain the truth. The author of the theory, however, did not anticipate and could not foresee the great changes which would come in the way of the cultivation of the land and in other ways to increase the food supply relative to the increase of population.

The time may come, to be sure, when the Malthusian theory will be revived, but it is not in our day, nor will it be in our century, for scientific thought almost completely overturned the theory and has relieved it of its strength in exciting the fears of economists or of philosophers that the world was gradually but surely coming to that position where it could not supply its population with food, and that some method of checking population must be the resort. The broadening of the area of supply through discovery and the taking up of vast tracts of land were the immediate means of depriving the doctrine of its force, but later on intensive agriculture and the discoveries of science succeeded in relegating the theory to the past. It is perfectly evident that science has accomplished more in reducing the theory to the minimum than all other forces combined; for transportation and telegraphy, by which famines are avoided or minimized, by which prices are equalized, by which the markets of the world are known every day, are the direct result of scientific discovery and of the application of the laws of nature.

Of course, Malthus depended upon the dogma of the older economists, that labor is the basis of all values, a doctrine which constituted the ground-rock on which Marx and his associates builded their socialistic structure. Science is steadily, and rapidly too, ridding the world of this doctrine, for, in connection with the Malthusian theory, it shows that labor, while the origin of values, is not and can not be the sole basis of all values.

In the light of present-day conditions there is little place for either the theory of the pressure of population upon the food supply or the theory that labor is the basis of all values. We are now having a wheat crop of nearly 800,000,000 bushels, a corn crop of nearly 3,000,000,000 bushels, an oat crop of close upon 1,000,000,000 bushels, and other crops in proportion. This

is for our own country alone, and it gives us the privilege of feeding the world and of relieving it of the fears of starvation or of the conditions of abject poverty; these are conditions which now affect few and exceptional cases, and not the masses.

Closely allied to the doctrine of the pressure of population upon the food supply is the law of diminishing returns, a law which holds now in all works on political economy. Science has not destroyed the law, but has modified it. It is fundamental and all-embracing, but is usually applied to the agricultural industry, although it extends in its principles to all industries, as that law of physics that increased speed is at the expense of power applies to all mechanical contrivances; and yet the law of diminishing returns, through scientific discovery and investigation, has been so far modified as to invalidate largely its relation to the Malthusian theory of population.

Volumes might be written relating to the influence that machinery has exerted in this respect—machines whose construction results in processes that parallel the work of the human brain and the human hand. Modern science shows that such machinery does not have the effect outlined by Doctor Smith in his story of the pin machine. To these machines we apply steam, compressed air, water, electricity. All the great forces of nature are brought into play, and through the ingenious contrivances of man supply the forces by which the law of diminishing returns is modified. In all directions this influence is observed; in a thousand directions we see the doing away with the rule of thumb and the application of distinct, positive scientific principles. The factory itself is a scientific structure, involving the highest mathematical skill. Through these things and the application of new principles in agriculture science overcomes the influence of the seasons by preserving products, by equalizing prices, and by all the other means by which the world is brought into closer contact, one nation or people with another.

The latest discoveries are, of course, the most effective in modifying the law. A gentleman in one of the eastern States has about seven acres under glass. He raises cucumbers, lettuce, and other things for the winter markets. A few years

ago he found that all the plants on the northern side of his houses grew slowly, lacking that development attained by the plants on the southern side. He alternated by transplanting. Still he found the plants on the northern side developed slowly and unsatisfactorily. Of course, he attributed this to the lack of sunlight on the northern side. When he had about given up the idea of securing any evenness in the growth of his plants the town inaugurated a system of electric lighting, and established along the northern side of his houses several powerful lamps. He then found that the plants on that side of his houses did as well as those on the southern side, the result being that he introduced electric lights in his houses, so that his plants should have the benefit of such lights all during the night. The effect of this was that his cucumbers, for instance, grew more rapidly, with more even development, and with a higher grade of tenderness. He sells about ten thousand cucumbers every winter at twenty cents apiece. This discovery was not new with him, for about that time scientific investigators in Italy and some other parts of Europe were experimenting in the use of electric light to perfect the growth of vegetables.

Afterwards my friend made another discovery, not new to the world but new to him, and that was that by sterilizing the soil he could stimulate the growth of plants to maturity, secure freedom from the growth of weeds and the influence of germs in the soil, and anticipate the market. This he did by putting gangs of steam-pipes in the soil about a foot deep, thus absolutely cooking the soil, killing all poisonous germs and all seeds of weed plants, while insects indigenous to the soil and injurious to the growth of vegetables entirely disappeared. He insists that the soil of any farm, conditions being favorable, can be sterilized in the same way, and at small cost, thus rewarding the farmer by relieving him of much labor now necessary in the cultivation of all kinds of plants and vegetables. Such experimentation must, of course, modify the law of diminishing returns to such a degree as, for a while at least, to rob it of its peculiar influence in increasing cost or retarding the supply from the cultivation of certain kinds of land; but, as I have said, the law remains as a law.

In mechanical productions science has also done much towards modifying the theory, although, of course, there is a limit to the power of machinery and to the employment of people that will always preserve the principle involved in the law; but in these directions—in the Malthusian theory of the pressure of population and its accompanying theory of the law of diminishing returns—science has done much to modify the tenets of the older economists.

The next matter in close relation to the Malthusian theory, and one which has yielded largely to scientific research and the application of scientific principles, is the iron law of wages—that law which provided that the workingman should and could receive only that amount of wage which was essential to life merely, just enough to keep body and soul together and to keep the human machine properly lubricated for its daily work. This law was fortified and reinforced by the wage-fund theory. Overcoming the one meant the modification or the complete abrogation of the other. The wage-fund theory did not originate with Malthus. It was suggested by Adam Smith himself, and was developed by his followers; but by the power of modern scientific analysis it is given up to-day, so far as its original form is concerned, by all economists, although many of them assert with some reason that it contains valuable truth, and, when properly stated, the whole truth.

As originally stated, the law is that wages, like everything else, are governed by supply and demand, and in the aggregate depend upon the proportion of laborers to the capital available for employing labor, this capital being denominated a wage fund. Doctor Smith said, in his Wealth of Nations, that the demand for those who live by wages, it is evident, can not increase but in proportion to the increase of the funds which are destined for the payment of wages. Malthus and Ricardo held to this doctrine, but argued that wages could not rise, even by increasing the wage fund, because if the wage fund were increased and wages were temporarily raised, population, according to Malthus, always pressing on the limits of subsistence, would be enabled to expand, and the increase in the number of laborers would increase the supply relatively to the wage fund,

and, therefore, lower wages. Ricardo held substantially this doctrine, as also did Senior, James Mill, John Stuart Mill, and most of the older writers of the classical school, though on this subject, as on others, John Stuart Mill later somewhat modified his views, and was, perhaps, often inconsistent.

As a result of more scientific consideration, this theory was practically abrogated, and a new one arose, which, in brief, is the theory that production furnishes the true measure of wages. Curiously enough, this theory was first clearly advocated in our own country, by the late President Francis A. Walker, when he argued that the wage-fund theory and its socialistic corollary were wholly false; that wages depended upon the productivity of labor and not upon capital. He says, in his work on the Wages Question, that the popular theory of wages is based upon the assumption that wages are paid out of capital, the saved results of the industry of the past. Hence, it is argued that capital must furnish the measure of wages. Walker held, on the contrary, that wages are, in a philosophical view of the subject, paid out of the product of present industry, and hence that production furnishes the true measure of wages, the employer purchasing labor with a view to the product of labor, and the kind and amount of that product determining what wages he can afford to pay.

This view has been very widely accepted, both here and abroad, Mr. Atkinson accepting and urging that the only way to raise wages is to raise the product, and applying his power of analysis, he says that in treating this question it must constantly be kept in mind that money is but the instrument of exchange, that real wages are what the money will buy, and that there can not be more real wages than the whole product less the share of capital. If, then, we can even approximate the value of the product and divide by the known number of persons employed, we then approximate the annual measure or average rate of wages in terms of money. In other words, to state it briefly, he says that capital must be paid first in order to induce it to contribute, but it is paid only just what is necessary in the market to obtain it, and the rest of the product goes to wages.

The formula of Adam Smith, indorsed and advocated by his

followers, is now revised, and should read, instead of as quoted, as follows: "The demand for those who live by wages, it is evident, can not increase but in proportion to the increase of product which is destined for the payment of wages." There have been many laws promulgated relating to wages, but I think that the scientific attitude of the present-day economists rests upon this theory; and it must stand until science restates it, and restates it in such a way that all or the majority of all economists will accept the formula. Certainly we must claim, and truthfully, that science has either abrogated or very largely modified the old theories relating to wages.

Another line of inquiry suggested by my topic relates to the ever-present, irritating, and much-controverted questions in regard to a tariff on imports. As yet science has done but little in this respect, but I conceive that it may and will do much in modifying the extreme views on either side that are held by economists, politicians, and statesmen. It may be granted that tariff legislation relates entirely to the question of expediency; that there is little, if any, principle involved in the doctrines of either free trade or protection. That is the present attitude of men, but the power of science is disturbing the older thought and the older doctrines on this great subject, for it is equalizing conditions everywhere, a process which goes on constantly, and which will help to show legislators the true path to be pursued.

In my own view the tariff question is more sociological than economic. Until the conditions of the different peoples that are engaged in competing industries are more thoroughly equalized, probably both the great political parties in our country, acting together, could not get rid of some form of a protective tariff, but when, through scientific methods and the application of scientific principles to industry on a broad scale, the conditions of the people become more thoroughly equalized, I doubt if both parties together will be able to preserve legislation relative to an expediency now felt to be important. A scientific basis of tariff legislation is sure to be advocated, and when it comes it will be the entering wedge to simplifying the commercial and industrial relations of different peoples. As already

intimated, the uniformizing of prices, the expansion of transportation, and all the other instrumentalities for reducing the size of the world from an industrial point of view, are affecting and will affect more generally legislation relative to imports and exports.

Scientific economics will lead the economists to depart somewhat from their older methods of treating the business affairs of the world. We have chapter after chapter, repeated in book after book, on the tantalizing questions of rent, interest, etc. Science can do but little towards avoiding the waste pages devoted to these subjects; they will remain, but they are chiefly the subject of discussion as to definition. As President Hadley has stated, political economy is very largely a conflict over definitions. This is harmless, but does little, if any, good. It is gratifying to see that the later works on political economy are making great steps in advance, are treating world-wide questions of present-day interest. They are recognizing the necessity of applying economic principles to the problems which vex us here and now, and that fine-spun theories as to matters having no interest or value as the days go by must give place to advanced treatment of the real, great questions which constitute the elements of industrial society at the present time.

Some of these questions which science will insist upon being treated will include the utilization of waste products. It is only scientific knowledge that can lead to this new development of values. A saved product is one of the necessities of industry at the present time. This utilization has taken place during the last few years, and it has upset some of the old theories as to cost and the returns of capital. By-products of all kinds are usually the source of profit, and in some cases the chief source of profit, to the manufacturer. This enables him to put out his units of original production at a less cost, and with benefit to the community. Nothing is lost which through scientific methods can be preserved. Many, many instances of this will come to the minds of all, but as one superlative illustration I may refer to the by-products of petroleum, which are absolutely, entirely saved through the practical application of scientific processes. It would be difficult to enumerate the products of

petroleum saved by the chemical processes of refinement. The Census Office has published a most enlightening bulletin on this very subject of waste products. This utilization of such products interferes with the full force of diminishing returns, modifying the law as progressing conditions demand.

Strange as it may seem, the influence of science upon the chapters relating to finance has been marked and positive. Prof. Charles E. Munroe, of George Washington University, has recently pointed out how technical chemistry invades the domains of economics, politics, and diplomacy, and he cites as a striking example of its effects in economics the settlement of the silver question. The far-reaching influence of chemistry in this particular line is easily understood when we consider the relations of the metals, and how these relations have been changed by the application of the principles of chemistry.

A further economic influence is to be found, as Doctor Munroe states, in the reference of a multitude of railroad administrative problems to the chemist, in the steady increase of his force of skilled assistants, and in the fact that his position in the organization has become second to none in importance. This is seen in the use of lamps, beacons, colors, and all the paraphernalia necessary for the conduct of great railway lines.

Economists have not yet adequately dealt with the great projections of modern times in relation to their influence upon economic development and the conditions of the people at large. Science will compel this treatment, and when our able and astute writers take it up we shall find illuminating chapters in the works on the ever attractive department of political economy. The great engineering enterprise, relating not only to transportation, but various other channels of industrial activity, must result in such treatment; but in transportation alone engineering science has revolutionized many economic conditions. Standing on the highest point of the Brooklyn bridge there are only three things to be seen—the sky above, the water below, and the vast creations of man filling the field of vision everywhere else. It is the application in every direction of the laws of nature, utilized by the power of science, that presents this scene to the human eye.

The constant effort of science to overcome natural laws as well as to apply them must be recognized. A few years ago, at a meeting in New York, a gentleman was deploring the fact that we did not allow Nature's law to have full play; that we were constantly antagonizing Nature at the expense of the welfare of the human race. Mr. Abram Hewitt answered this pernicious doctrine by saying that if Nature had been allowed to take its course grass would still be growing in Broadway.

The sociological results of this conflict are too vast for present treatment; they can only be suggested. Congested cities are being relieved of their congestion, and the great suburban population, the finest in the world, is recruited from the congested districts and from the country. Through sanitary discoveries, and through many other elements which are the direct result of scientific processes, we are reducing the power of disease and delaying the time when one ceases to exist. Rapid transportation and the great lines of transportation are facilitating the accomplishment of these wonderful and desirable results. They are reducing the possibilities of war by increasing its severity; they are making the products of one clime familiar to all climes; they are diffusing intelligence and making all people acquainted. Political economy has a vaster field in massing the facts which pertain to this broad branch of its grand science than it has as yet occupied.

Growing out of this will come a saner and more rational treatment of the power of machinery in its effect upon the employment of the people. The facts already show that in this country particularly the percentage of the whole population employed in gainful occupations constantly rises. The older economists did not have the facts. They had to draw their conclusions from exceedingly limited observation, but with the data covering the whole people the old views are overturned, and we now recognize, as the result of statistical inquiry, that not only does the percentage of the total number of people employed increase, but that the development is along the lines of the most skilled labor and in the higher pursuits of life; that the great body of people constituting the base of the industrial pyramid is constantly being narrowed, and to the benefit of the

whole. Scientific inquiry in these directions, added to that concerning the great engineering processes, must lead to but one, and that a scientific, conclusion.

Scientific political economy must deal with the question of alimentation, which is important in all treatment of the labor question, and is one of the most vital subjects to attract present-day thinkers. The physiological chemist is claiming attention, and rightly. He is trying to ascertain just what foods are most important, not only from a physiological point of view but economically, and as relating to the efficiency of labor. Professor Marshall has lately made an appeal for a larger number of sympathetic students who have studied working-class problems in a scientific spirit; under this spirit this question of food and the efficiency of labor as depending upon the quality of food must be one of the problems. What is the amount of nutrients contained in different food materials? The relative expense of different kinds of food? The ratio of relative costs of protein, fats, and carbo-hydrates, as well as the relative proportion of these elements? These facts are being ascertained, and it is necessary to know them and the influence of each upon the muscular as well as the mental capacity and development of the individual.

The economy of food must be treated from two standpoints—the physiological and the pecuniary. These elements can not be separated if we are to understand fully the effects of different foods upon the efficiency of labor and the capacity of labor to sustain itself. These things should form a part of political economy. They are certainly far more valuable than any treatise upon rent or interest. Much has been done, but more must be accomplished. Governments, both State and Federal, as well as municipal, are becoming interested in these subjects, our own Federal Government for some years having carried on investigations relative to nutrition. The Carnegie Institution of Washington has taken up this subject with most friendly interest, and under its direction some of the wisest and most skillful experts of the country are conducting their experiments. The Federal laboratories are auxiliaries to this inquiry, and I feel sure that with the united efforts of governments, of scien-

tific institutions, and of professors in colleges and universities there will be produced a body of facts that will clearly and definitely decide the great question of efficiency of labor, so far as food is concerned.

Going back some years, you will remember that Lord Brassey, when contracting for the labor of men of different nationalities in the construction of railroads, found by actual experience the effect produced by different kinds and qualities of food; that when the food of the Italian laborer was changed from macaroni and other things belonging to his national diet to roast beef and those things which make the British workman so superior, his efficiency was increased *pro tanto*.

It is difficult, through any statistical method or through any method depending entirely upon observation, to treat the labor question in all its elements in a way to secure beneficial results, so far as knowledge is concerned. The statistics of wages have undergone a very decided evolution through the application of scientific methods suggested by economists. It can be learned easily—and has been stated—how many men are required permanently to perform the services of a larger number of men employed temporarily. The efficiency of labor relates specifically to this subject. For instance, it was ascertained a few years ago that in a number of establishments producing pig-iron 310 different employees were required to carry on the works, but that if the workmen had been employed continuously only 71 would have been necessary; that the average earnings of the 310 individual employees were $169, while the consequent average earnings per employee if the work had been continuous for the 71 men would have been $734 per year. A scientific economic analysis of such conditions would probably show a variance necessary to a true economic conclusion; but political economy has not yet attacked such problems with the same force with which it has dealt with other and less important matters.

The treatment of the labor question must, if there are great results to be secured, be brought under the same scientific methods that are applied in other directions; and there are various other statistical elements which, for the intelligence of

all people, both employers and employed, require the application of scientific analysis, for I take it that the relations of employer and employee will not be as fully harmonized as may be desired until such application is made. The employer does not understand fully the conditions of his own work; the employee certainly does not understand the conditions of production. All these conditions are the result of scientific development, and that development, in order to secure the very best results in establishing a rational basis for treatment, must have further elucidation before great results can be expected.

As another instance, the volume of products at different periods, as shown by values, is the prolific source of most pernicious doctrines. Our official statisticians have been wrestling with this subject for many years, and some advance has been made, especially during the last national census. I refer particularly to the duplication of values. We say that the product of the mechanical and manufacturing establishments of the United States is, in round numbers, over $13,000,000,000, but this amount represents the value of raw material and labor, each producer returning the full value of his product, which may become the raw material of other manufacturers all along the line. The deduction of the value of the raw material from the total value of the products, of course, simplifies the problem, but it does not scientifically solve it. Scientific methods must be resorted to, and if the political economists, in connection with their allies, the statisticians, will undertake this problem greater progress will be made. So far hints only are to be found in the books. These hints, of course, are familiar to all statisticians, but the difficulty of securing the true product without exhausting the treasury is one of great complexity.

So in the whole field of sociology, involving crime, charity, benevolence, and all that pertains to the efforts of society to remedy existing evils, we need a new method of treatment. There is such a thing as scientific charity, which is immediately concerned with the economic welfare of the people. The great questions of insurance—how to remedy or provide for the economic insecurity which belongs to the present wage system,

the compensation of workingmen for accidents, and everything of the kind—must be the subject of treatment by political economists. They will need all the science of the actuary, all the skill of the statistician, and all their own power of analysis.

You may ask what can be done in these respects. The official statistician, who, as I have said, is the ally of the political economist, and who recognizes the scope and the necessity of all that is taught in orthodox political economy, also recognizes the need of the further application of economic analysis in the use of the data he collects. He can not study these questions except from the statistical point of view. His duty is to collect, classify, and publish facts relating to the conditions of the people. Their economic interpretation must be, and largely too, the work of another class.

Prof. Simon Newcomb, in a tentative way, has made some suggestions along these lines. These suggestions have been submitted to the Carnegie Institution of Washington, with the hope that that Institution may effectively promote not only research in the exact sciences but the analysis of data that are now in existence. He says that the nineteenth century industriously piled up a vast mass of sociological observations and data, as well as data relating to other branches of science, and that this accumulation is going on without end and at great expense in every civilized country. This proposition we all admit. The problem of working out the best results from these observations, however, is one which is not being effectively grappled with, the consequence being that what has been done toward obtaining results consists largely in piece-meal efforts of individuals, frequently leading to no well-established conclusions. He asserts that another feature of the situation is the gradual extension of the principles of exact science into the sociological field; that it is through this extension, rather than through adding to the already accumulated mass of facts, that progress is most to be hoped for in the future.

He therefore suggests that a body of men be employed, organized into a bureau of exact sciences in general, whose work shall be the development of mathematical methods and their application to the great mass of existing observations. He

understands well, of course, the difficulty of securing just the right men who can take up in a sociological way—although his suggestions embody many other branches—the exact scientific analysis and interpretation of facts in existence.

Evidence comes from other sources. Dr. Karl Pearson, of University College, London, in commenting upon Doctor Newcomb's suggestion, states that a man of mediocre ability can observe and collect facts, but that it takes the exceptional man of great logical power and control of method to draw legitimate conclusions from them. He thinks that at least 50 per cent. of the observations made and the data collected are worthless, and that no man, however able, could deduce any result at all from them; that, in the language of engineers, we need to "scrap" about 50 per cent. of the products of nineteenth century science; that the scientific journals teem with papers which are of no real value at all, recording observations that can not be of service to any one, because they have not been undertaken with a due regard to the safeguards which a man takes who makes observations with a view of testing a theory of his own; that in other cases the collector or observer is hopelessly ignorant of the conditions under which alone accurate work can be done; that such a man piles up observations and data because he sees other men doing it, and because that is supposed to be scientific research.

Professor Pearson feels that sociological observations are of the lowest grade of value in too many cases; that even where the observers have begun to realize that exact science is creeping into the sociological field they have not understood that a thorough training in the new methods is an essential preliminary for effective work, even for the collection of material; that these observers have rushed to measure or count any living form they could hit on without having planned *ab initio* the conceptions and ideas that their observations were intended to illustrate.

Doctor Pearson is skeptical about the right men or the right man, and he thinks the securing of these men is the chief difficulty in organizing any force for the scientific interpretation of the great mass of data now existing; but he says that when the right man is found he must have been rightly trained;

that he is to be occupied in drawing logical conclusions from other persons' observation and data; that, therefore, he must, in the first place, be an adept in scientific method, a first class mathematician and statistician, and a trained calculator and computator. Such a man will be the man who has the courage to "scrap," and to do it relentlessly. Science wants immensely the courageous pruner, but Doctor Pearson feels that such a task is not an enviable one.

Such a work is also indorsed by Lord Rayleigh, of the Royal Institution of Great Britain; and Dr. H. H. Turner, of the University Observatory at Oxford, in sympathizing with Doctor Newcomb's suggestion, does not hesitate to say that no one will be found to doubt the necessity of a far more extended discussion of results; that in the days of Newton, perhaps, observations were scarcer than theories, and it was advisable to set them going, but that now there is no doubt whatever that there is a crying necessity that we should organize the discussion of the masses of accumulated material.

Dr. S. H. Darwin is also in sympathy with such work, while in this country Doctor Fisher of Yale, Dr. Pickering of Harvard, and others, are agreed that we must utilize the vast collections of data and the results of observation in a more scientific way in order that the conditions of the people in all sociological aspects shall be more clearly defined.

All these suggestions are stimulated by what is known as the new political economy. Personally, I do not particularly like that expression, but I do like the phrase "social economics," because while political economy deals with the accumulation, distribution, and exchange of wealth—fields perfectly legitimate—and sociology is the science of the relations of individuals and institutions, social economics deals with relations in industrial society; hence it comprehends in a broad sense all that is comprehended by political economy, as well as those other elements of present-day economics which relate to other passions than the passion of wealth. We must agree, however, with Buckle, that "wealth must accumulate before knowledge can begin," and its corollary, that "Great ignorance is the fruit of great poverty." We must also recognize Whewell's utter-

ance, that in all cases the arts are prior to the related science. Art is the parent, not the progeny, of science. The wants of the world have developed science. The old alchemists in their work preceded chemical science. So the empirical investigations and researches to discover remedial agencies have bequeathed to the world great stores of knowledge now systematized.

We must also recognize that during the past one hundred and twenty-five years or so political economy, as a separate branch of philosophy, has sprung into existence. The age has been conducive to its development, for it has been one of material progress. Economics has ruled almost at the expense of ethics, notwithstanding during the same period the world has been constructing great charitable and educational institutions, emphasizing its desire to benefit the human race. These institutions, however, have fallen far short of their true purpose. Much of the charity of the world—unscientific, unreasonable—has resulted in more densely populating penal institutions. The scientific investigations of the present time are remedying this fault, and are showing that economics and such institutions must be considered together.

All the strides civilization has made command our admiration, and its onward steps are marked by numerous and convincing evidences; but such evidences are outside the science of political economy, and are considered by it only as the cost may enter into the distribution of wealth it seeks to create, but not as means for a happier and better condition wherein wealth could be more successfully produced.

Under the spur of this progress political economy has flourished—first, by the patronage and through the admiration of all classes. England did not give it birth, perhaps, but cared for it through its infancy, and gave to the world the more matured growth which we call political economy; but England's writers claim that she owes her industrial position in the past to it. It may be that to a too blind following of later teachings she owes to-day the partial loss of her old industrial supremacy. America, if she desires to occupy the place England is vacating, must take lessons of her mother, and profit by her mistakes and advance her scientific understanding to economic truths and principles.

The old school has been content to teach the laws that regulate the production, distribution, and exchange of wealth, and these laws have, in large measure, and wholly until more recent years, constituted the science of political economy. It has studiously avoided all other matters, and, in the endeavors of its devotees to constitute it a science, has taken no cognizance of the conditions which, favorable or unfavorable, must attend the participators in the production, distribution, and exchange of commodities. It has been content to limit itself to things and their relations to individual and national wealth, more particularly the latter, rather than to include in its sphere of creed the vital relations of men. Even Mr. Mill, perhaps the most brilliant writer of his age, informed us that "political economy is concerned with man solely as a being who desires to possess wealth, and who is capable of judging of the comparative efficacy of means to that end. It makes entire abstraction of every other human passion or motive, except those which may be regarded as perpetually antagonizing principles to the desire of wealth, namely, aversion to labor, and desire of the present enjoyment of costly indulgences. . . . Political economy considers mankind as occupied solely in acquiring and consuming wealth." This statement was made in 1844.

Prof. John K. Ingram, in 1879, called this a vicious abstraction, which meets us on the very threshold of political economy, and the strictures of our own Professor Walker upon this saying are too well known to be quoted here.

Mr. Mill's statement represents the tenets of the old school, although the founder of the science, Adam Smith, began his labors in it as a professor of moral philosophy, and taught it as a branch of that philosophy. His followers, in their ambition, for many years strayed far from the doctrines of their great master, and with their departure from him political economy lost the sympathy and even the attention of the wage-workers of English and American communities, the very support it largely needs and should have.

It is most gratifying to know that our modern economists are recognizing the weakness of the old doctrines. They are recognizing the necessity of more scientific treatment, of an

analysis of conditions, of an interpretation of facts and observations in considering the great wants of the present day. Political economy, like theology and religion, must change with the thought of the age; it must change as industrial and social conditions change; it must seek to ally itself with all the great sciences in every line of work, and to reach conclusions that shall be of vital importance to the working masses of the world. It is a happy sign, as already intimated, that the newer works on political economy are recognizing these things, and are extening the field of their discussions. Here is the great hope, and herein lies the importance of the relation of science to political economy. Science is always ready, when the results of its investigations warrant it, to wipe off the slate of yesterday and turn its face to the light. Political economy has not always done this, but it should be as ready as science has been to follow new revelations and announce new truths.

SECTION A.

Mathematics and Astronomy.

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ADDRESS

BY

OTTO H. TITTMANN,

VICE-PRESIDENT AND CHAIRMAN OF SECTION A FOR 1904.

THE PRESENT STATE OF GEODESY.

The problems of geodesy, like those of most sciences, enter upon new phases with the accumulation of facts bearing upon them. The problem of determining the amount of the earth's compression was added to that of determining the size of the supposed sphere as soon as Newton had demonstrated its oblateness. The controversy to which Newton's theory gave rise was settled by the famous geodetic operations of the eighteenth century which furnished the cardinal facts in regard to the earth's figure and size.

What may be regarded as the slow progress of a more precise knowledge of the earth's dimensions since that time must be attributed to the difficulties inherent in the problem.

In the first place the dimensional measurements must necessarily be confined to the continental areas which occupy but three-elevenths of the earth's surface. The configuration and relationship of these areas make it impossible to girdle any section of the earth by direct measurement.

Secondly, the admeasurement of these areas is far beyond the reach of individual enterprise and can only take place when the practical needs of governments suggest the utility of great mensurational surveys which at the same time and without great additional expense will furnish the data required for a more perfect knowledge of the spheroid. In making this statement it is not forgotten that individuals and governments

did undertake in all ages measurements for the purely scientific purpose of determining the size of the earth, for the desire for knowledge on this subject may be reckoned coeval with intellectual development of man.

Happily it may be said also that by their collective action the governments of the world have shown in recent times that it is considered a governmental function to support and promote researches in this branch of science. I allude, of course, to the existence of the International Geodetic Association. It will not be out of place to say in this connection that the association exists by virtue of a formal convention between the participating governments, which are, at the present time, the United States, Japan and Mexico and all the European nations save Portugal, Roumania and the group south of the Danube. No account of geodesy would be complete that failed to consider the aims and labors of this association. Its history is part of the history of geodesy since 1861. At that time it began its career as the Mittel Europäische Gradmesung. In a few years it expanded into an European association and in 1886 it became international.

It is not generally known that it was this association which instigated the French government to invite the world to establish an international bureau of weights and measures at Paris. Without detracting in any way from the labors of Bessel, Clarke and others in intercomparing geodetic standards, the successful labors of the bureau which in consequence was established in Paris removed at least some of the difficulties that were encountered by the investigators in this branch of science, and by those engaged in the practical work of the measurement of the earth.

The history of geodesy is full of instances of confusion and wasted energy due to the lack of a common standard, and the results of many arc measures which would at least have great historic interest are utterly lost to us, because we can not make even a respectable guess at the units used. The adoption of an international unit of length and its necessary auxiliary, a common thermometric scale, and the provision which the various governments made for the reference of their

measuring apparatus to a common unit was a step of fundamental importance.

The association as such has no control over the geodetic operations conducted by the different governments. Its function is to be the intermediary where coöperative action is needed, and to discover and point out along what lines the greatest need for information exists.

In pursuance of these duties it has helped to perfect the European systems of triangulation by showing where missing links should be supplied, not only by measurements of angles and bases but also by additional astronomical observations. It has made absolute gravity determinations with all the accuracy demanded by modern science and has caused suitable connection to be made by relative measures between widely scattered pendulum base stations, and it has instituted unique relative gravity measures, to which further reference will be made. It organized and maintains the stations for observing the variation of latitude in regard to which it should be remarked that it is the desire of the association to continue the observations beyond the year 1906, which marks the end of the ten-year period for which that service was tentatively organized. The association strongly desires not only to continue but to extend the service to the southern hemisphere and other latitudes than those now occupied by the permanent stations, and to obtain the co peration of suitably situated observatories in their endeavor to discover the cause of the phenomena.

That the problem of determining the earth's dimensions could not be solved by simply measuring two arcs in suitable localities was brought home to geometers by the anomalous results obtained in the eighteenth century. For instance, according to Lindenau the combination of the two American arcs, Mason and Dixon's measured in 1764, and that of Peru, measured a quarter of a century earlier, gave a value of one five-hundredths for the earth's compression. The value derived from those measured in Great Britain alone was about nine times as great, or one fifty-fifth, while those made in France, considered by themselves, gave one one-hundred-and-

fiftieth. It is not now important to inquire whether these differences are not in part due to the crudities of the methods of measurement employed. They were sufficiently real to throw doubt on the belief that the earth could be represented by a regular mathematical figure. Finally, the existence of local deflections of the vertical as affecting the amplitude of arcs was recognized, but not taken into account save, perhaps, by arbitrary exclusion of stations showing exceptionally large deflections.

The method of finding an osculating spheroid from arc measures remained in its essence that of taking averages of measurements reduced to the geoidal surface. The differences between the observed directions of the vertical and those computed on an assumed spheroid of reference were treated as if they were accidental errors of observation. At the present time it is the aim of geodesists to assign to the deflections their proper place in the computations and to interpret them by discovering through them and through gravity measurements the manner of the distribution of masses in the interior of the earth. Thus geodesy is trenching on the domain of geophysics and geology.

In India, in Europe and in the United States the study of these deflections is receiving special attention. In the last-named countries the junction and correlation of the triangulation, which was formerly disjointed, makes it possible to take up the study. Similarly in this country the completion of the transcontinental arc and its connection with the lake survey triangulation furnished the opportunity and occasion for adopting a standard datum of geographical coördinates for the whole country. This in turn furnished the deflections of the vertical referred to a common origin of coordinates on the same spheroid and made it possible to begin the study of the form of the geoid in this country over a very extended area.

The investigation has so far been extended over the eastern part of the United States. Here as elsewhere it was found that the curves of elevation of the geoid above the spheroid reflect perceptibly the visible topographic features.

A preliminary statement of the scope of these investigations

was recently given before the International Geographic Congress by Mr. Hayford, the chief of the computing division of the Coast and Geodetic Survey. From it I quote as follows:

"The conclusion that for the eastern half of the United States and the adjacent portion of the Atlantic the theory of isostasy is true to a considerable extent is reasonably safe. The conclusion that the depth within which the isostatic compensation takes place is 205 miles is one which may be modified considerably as the investigation proceeds.

"The investigation thus far leaves the signs of the corrections to the constants of the Clarke spheroid of 1866 uncertain."

Mr. Hayford will give before this meeting an account of the method devised by him of computing the topographic correction. The task of computing this correction to a distance of 4,000 kilometers for each of say 500 stations has been rendered possible by this method, which is, therefore, referred to by me as a distinct advance in geodesy.

It is hoped that the completion of the study of the data now available in regard to the deflections will serve as a guide to the most effective use in the future of the pendulum, and it is on this account largely that pendulum observations have been for the present deferred by the coast survey. They are, however, being actively made by other nations.

A new impetus was given to relative gravity observations by the adoption of short and light pendulums in place of the heavy seconds' pendulum. Aside from their portability, their lightness insures greater invariability for the knife edges, simplifies the task of securing uniformity of temperature and pressure in the metal cases in which they are swung, and the ease with which a low and constant pressure can be maintained in the case insures the continuance of the swing through so long a period that the errors of the chronometer or other timepiece are eliminated. Thanks to the efforts of the International Geodetic Association, the widely scattered base stations have been connected with the central station of the association at Potsdam, where a long series of absolute gravity determinations were brought to a successful conclusion two years ago. The association has available now the

data from nearly 1,800 stations scattered over various parts of the globe. A most interesting and valuable extension of relative gravity measures to the surface of the ocean was made two years ago. The principle upon which the new method depends is that if the atmospheric pressure is determined at the same time and place by means of a mercurial barometer on the one hand and by the temperature of the boiling point of water on the other, the observed height of the barometer will be affected by gravity at the place, while the result by the hypsometer will be independent of it. According to Dr. Hecker, who carried out the laboratory experiments as well as the actual test at sea, the suggestion that the two instruments might be used for the determination of differences of gravity was first published in 1894 by Dr. Guillaume, of the International Bureau of Weights and Measures at Paris. Dr. Mohn, of Christiania, successfully applied the method by actual tests in various places in Norway for the purpose of determining the gravity reduction of the barometer for meteorological purposes. Doctor Hecker installed his apparatus on a steamship and sailed from Hamburg to Rio Janeiro via Lisbon, Portugal, and Bahia, Brazil, and returned on another steamer to Lisbon, making observations both ways. The results of his observations have been published and show:

1. That the intensity of gravity on the Atlantic Ocean between Lisbon and Bahia is nearly normal, and agrees with the theoretical values computed by means of the general formula published by Helmert in 1901.

2. That the difference of gravity at sea in shallow water and in deep water corresponds approximately to the difference of gravity between coast stations and inland stations.

These results were submitted to the Geodetic Association at the last meeting. Means were provided for another expedition and last March Dr. Hecker began his journey, crossing the Indian Ocean and the Pacific by way of Melbourne and Sydney to San Francisco. Thence he recrossed to Japan and China, and we may look forward to an early statement of the results, which are being awaited with deep interest.

As in the case of the pendulum already referred to, there

has been in the last decade a decided improvement and simplification in instrumental means and methods of work. It is only necessary to cite the introduction of tapes and wires for primary base measurement, the introduction of the transit micrometer for the elimination of personal equation in time determinations, and of the leveling instrument, devised in the coast survey, which is making its way into more general use. With the use of the latter there has just been satisfactorily completed the first precise line connecting the Atlantic, Gulf and Pacific mean sea levels in the coasts of the United States.

In all countries the determination of the mean sea level and the establishment of so-called bench marks in the interior are being actively prosecuted as they furnish part of the required geodetic data.

In beginning I referred to the measurement of continental areas. Let us see what has been accomplished as to the extent of areal measurement since Snellius introduced triangulation into geodesy 289 years ago. In our own hemisphere, so far as I am able to learn, about the three-hundredth part of one per cent. of the area of South America has been covered; of Mexico about one per cent.; of the United States about five per cent. Geodetically the British possessions in the western hemisphere are barren. We may say that less than three per cent of the western hemisphere has been triangulated.

In the eastern hemisphere we find that about forty per cent. of Europe has been covered, but if we leave out Russia the percentage rises to eighty per cent. for the rest of Europe.

The triangulation of Asia is furnished by India and Japan, Java and Sumatra and amounts to about four per cent.

Australia shows about two per cent., Africa about two and six-tenths per cent., making a total for the eastern hemisphere of about seven per cent.

If we exclude the north and south polar regions a little over six per cent. of the available land area has been triangulated, or about one and one half per cent. of the total surface of the globe. These figures are accurate enough for the purpose for which they were compiled, that is, to show the relatively small area covered. There is, however, another side

to the picture, the hopeful one. In South America the arc of Peru is being remeasured and extended by the French government. As the work is being carried out with the advice of the most distinguished mathematicians of France, the results will be, in their importance, out of all proportion to the extent and area involved.

Mexico has made a brave beginning and is working towards a connection with an extension of the ninety-eighth meridian measurement, of which the United States has completed about three quarters of the amplitude lying in her own domains. Work on the Pacific coast arc has been resumed and it has nearly been completed from San Diego to the Columbia River.

Two years ago the Russians and Swedes jointly completed an arc in Spitzbergen between latitudes 76° and 81°. The European arcs are being extended eastward by Russia, and one must look forward to the ultimate connection between the Russian triangulation at Astrakhan or Orsk and the Indian triangulation, however improbable it may seem if looked at from a political viewpoint.

In Africa the work of extending the South African arcs northward from the Cape towards Alexandria is well under way, and no doubt need be entertained that the British and Germans will carry it through.

A general review of this part of the field of geodesy shows that while some great geodetic measurements have been completed or are approaching completion, new ones are being undertaken under the fostering care of different governments.

Reasoning from the experience of the past, we may conclude that the solution of one problem in geodesy will disclose the existence of another, and from the trend of the investigations of the present that other than purely mathematical and astronomical sciences will be advanced by the search for their solution.

That the progress of the branches of science to which this section of our association devotes itself was greatly affected by the problems of geodesy was pointed out by Humboldt in language which may fittingly conclude these remarks:

"Except the investigations concerning the parallax of the

fixed stars, which led to the discovery of aberration and nutation, the history of science presents no problem in which the object obtained—the knowledge of the mean compression of the earth and the certainty that its figure is not a regular one—is so far surpassed in importance by the incidental gain which, in the course of long and arduous pursuit, has accrued in the general cultivation and advancement of mathematical and astronomical knowledge."

PAPERS READ.

SYMMETRICAL AND UNSYMMETRICAL RELATIONS IN THE EXACT SCIENCES. BY JOSIAH ROYCE. (Presented in connection with the Vice-Presidential programme and published in SCIENCE.)

SYNCHRONOUS VARIATIONS IN SOLAR AND METEOROLOGICAL PHENOMENA. BY H. W. CLOUGH. (To be printed in the Bulletin of the U. S. Weather Bureau.)

TEMPERATURE CORRECTIONS OF THE ZENITH TELESCOPE MICROMETER, FLOWER ASTRONOMICAL OBSERVATORY. BY C. L. DOOLITTLE.

RESULTS FROM OBSERVATIONS OF THE SUN, MOON AND PLANETS FOR 26 YEARS. BY J. R. EASTMAN.

DETERMINATION OF THE SOLAR ROTATION PERIOD FROM FLOCCULI POSITIONS. BY PHILIP FOX. (To be printed by the Carnegie Institution.)

DETERMINATION OF ALL NON-DIVISIBLE GROUPS OF ORDER p^mq WHICH CONTAIN AN ABELIAN SUBGROUP OF ORDER p^m AND TYPE [1, 1, 1 . . to m UNITS]. BY O. E. GLENN.

A NOTE ON GROUPS OF ORDER 2^m WHICH CONTAIN SELF-CONJUGATE GROUPS OF ORDER 2^{m-2}. BY G. H. HALLETT.

BIOLOGY AND MATHEMATICS. BY G. B. HALSTED.

THE PATH OF THE SHADOW OF A PLUMMET BEAD. BY ELLEN HAYES. (To be printed in POPULAR ASTRONOMY.)

The Computation of the Deflections of the Vertical due to the Topography Surrounding the Station. By J. F. Hayford.

Extension of a Theorem due to Sylow. By G. A. Miller. (To be printed in the Bulletin of the American Mathematical Society.)

On Inversions. By J. J. Quinn.

On Systematic Errors in Determining Variations of Latitude. By Frank Schlesinger. (To be printed in the Astronomical Journal.)

Some Experiments on the Distortion of Photographic Films. By Frank Schlesinger.

Bibliography and Classification of Mathematical and Astronomical Literature at the Library of Congress. By J. D. Thompson. (To be printed by the Library of Congress.)

On an Optical Method of Radial Adjustment of the Axes of the Trucks of a Large Observatory Dome. By David Todd.

An Exhibition of a New Form of Frame for Straight Line Mathematical Models. By C. A. Waldo.

The Application of Mayer's Formula to the Determination of the Errors of the Equatorial. By L. G. Weld.

[The following papers were read before the Astronomical and Astrophysical Society of America, meeting in affiliation with Section A.]

THE CONSTANT OF ABERRATION. BY C. L. DOOLITTLE.

A TEST OF THE TRANSIT MICROMETER. BY J. F. HAYFORD.

REMEASUREMENT OF THE HOUGH DOUBLE STARS. BY ERIC DOOLITTLE.

NOVEL DESIGN FOR ROTATING DOME TRACK. BY D. P. TODD.

A STUDY OF THE DRIVING WORMS OF PHOTOGRAPHIC TELESCOPES. BY E. S. KING.

THE REFLEX ZENITH TUBE. BY C. L. DOOLITTLE.

VARIATIONS OF THE BRIGHT HYDROGEN LINES IN STELLAR SPECTRA. BY ANNIE J. CANNON.

VARIABLE STARS IN LARGE NEBULOUS REGIONS. BY HENRIETTA S. LEAVITT.

PLANETARY SPECTROGRAMS, THE WORK OF SLIPHER LAMP AND ANOTHER. BY PERCIVAL LOWELL.

THE CANALS OF MARS. AN INVESTIGATION OF THEIR OBJECTIVITY. BY PERCIVAL LOWELL.

NOTE ON THREE SOLAR PERIODS. BY F. H. BIGELOW.

THE COORDINATION OF VISUAL AND PHOTOGRAPHIC STAR MAGNITUDES. BY J. A. PARKHURST.

THE QUADRUPLE SYSTEM OF ALPHA GEMINORUM. BY H. D. CURTIS.

USE OF THE METHOD OF LEAST SQUARES TO DECIDE BETWEEN CONFLICTING HYPOTHESES. BY HAROLD JACOBY.

TABLES FOR THE REDUCTION OF ASTRONOMICAL PHOTOGRAPHS. BY HAROLD JACOBY.

RECENT RESEARCHES OF THE HENRY DRAPER MEMORIAL. BY E. C. PICKERING.

CALIBRATION OF A PHOTOGRAPHIC PHOTOMETER WEDGE. BY ORMOND STONE.

USEFUL WORK FOR A SMALL EQUATORIAL. Discussion opened by E. C. PICKERING.

SECTION B.

PHYSICS.

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ADDRESS

BY

EDWIN H. HALL,

VICE-PRESIDENT AND CHAIRMAN OF SECTION B FOR 1904.

*A TENTATIVE THEORY OF THERMO-ELECTRIC ACTION.**

Let the lines (1)–(1) and (2)–(2) in Fig. 1 be the lines representative, respectively, of two metals M_1 and M_2 in the ordinary thermo-electric diagram. We may, if we please, think of these metals as copper and iron, respectively. The lowest horizontal line is the temperature coordinate and begins at the absolute zero.

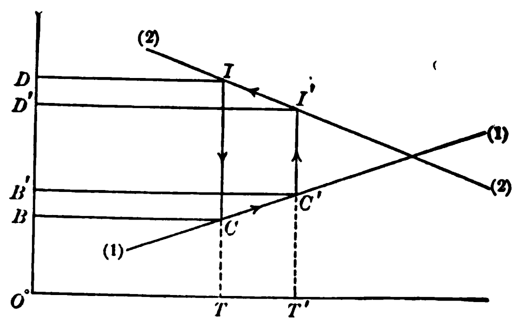

FIG. 1.

The diagram is so constructed that the area $CC'I'IC$ is equal to the net thermo-electromotive force, E, counterclockwise, in the circuit indicated by Fig. 2, in which the left-hand junction

* The theory here given is certainly incomplete, and I fear that it is not entirely self-consistent. It is intended to be suggestive rather than conclusive or exhaustive.—E. H. H.

is kept at temperature T and the right-hand junction at temperature T'. We will suppose that E is expressed in mechanical units, as the amount of work done, at the expense of heat, on unit quantity of electricity while it goes once around the circuit. Evidently, then, the area $CC'I'IC$, which represents E, represents also the mechanical equivalent of the net amount of heat consumed by unit quantity of electricity in one cycle.

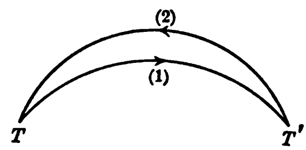

FIG. 2.

The arrow-points in Fig. 1 indicate merely the direction of the current resulting from the net E of the circuit.

It is consistent with what precedes to consider the area $BCC'B'B$ as representing that part of the total, or net, E which lies in the unequally heated M_1 between T and T', the area $B'C'I'D'B'$, as representing that part of E which lies in the junction M_1-M_2 at T', etc.; and this interpretation is sometimes given as a mere statement of fact. In the course of this paper it will, I hope, be shown that another view of the matter is consistent with the known facts of the case.

As this declaration puts me for the moment into a somewhat heretical attitude, let me hasten to say that I hold as strongly as any one to the proposition that the area $BCC'B'B$ represents the amount of heat absorbed by unit quantity of electricity in going through the metal M_1 from the temperature T to the temperature T', that the area $B'C'I'D'B'$ represents the heat absorbed by unit quantity of electricity in going from M_1 to M_2 at temperature T', etc. This proposition is familiar and needs no proof from me; but I wish to develop a little one aspect of it which is sometimes overlooked, an aspect which has a decided pedagogic value and which is at least suggestive of the line of thought I wish to follow later.

As we have in Fig. 1 a diagram in which areas represent heat absorbed, and in which one of the coordinate axes represents

temperature, the other axis must represent entropy. Let us, therefore, in order to conform to the common practice in the use of the temperature-entropy diagram, make the T axis vertical, and the entropy, or S, axis horizontal, thus getting, as the equivalent of Fig. 1, the Fig. 3.

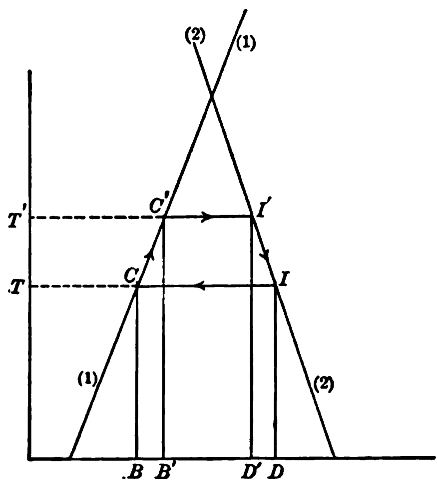

FIG. 3.

It is to be observed that Fig. 3 is the obverse of Fig. 1, so that the arrow-points, without any relative change of position in going from one figure to the other, now lead clockwise around the area $CC'I'IC$.

Any one who is familiar with the temperature-entropy diagram of the steam-boiler-engine cycle, as given and discussed by Ewing, will see at once interesting points of resemblance between Fig. 3 and that diagram. For example, the sloping line CC', which indicates one phase of the Thomson effect, the absorption of heat by the electric current in passing through the metal M_1 from a point at temperature T to a point at the highest temperature, T', is analogous to the sloping line which in the steam-boiler-engine diagram indicates the absorption of heat by the feed water from the condenser in mixing with the hot water in the boiler. The slope of each line implies that the working agent, electricity in one case and water in the other, takes in the

particular quantity of heat represented by the area under the line at a temperature below the highest of the cycle, and, therefore, does not make the best possible thermodynamic use of the heat supplied and of the range of temperature available. Similarly the inclined line $I'I$, which indicates that heat is absorbed by the electric current in passing through the metal M_2, from temperature T' to the lower temperature T, is analogous to the line of the steam cycle which indicates the recovery of heat from the cylinder wall during expansion after cut-off.

Furthermore, the horizontal lines $C'I'$ and IC, indicating the absorption or emission of heat by the electric current in passing, without change of temperature, from one metal to the other, are analogous to those horizontal lines of the steam cycle which indicate absorption or emission of heat in the act of evaporation or of condensation. To this analogy we shall presently return.

Let us for the moment occupy ourselves with a re-examination of the prevailing opinion as to the relation between the heat absorption or emission at the junction of two metals and the difference of potential, or the electromotive force, at that junction, that is, between the thermal aspect and the electrical aspect of the Peltier effect. We shall find the situation not quite so clear as it is often supposed to be.

Maxwell* states that the amount of heat taken up or given out by unit quantity of electricity in going from one metal to another at any temperature is a measure of "the electromotive contact force at the junction"; and he says that "this application * * * of the dynamical theory of heat to the determination of a local electromotive force" is due to Sir Wm. Thomson.† He then goes on to declare that, "the electromotive force at the junction of two metals, as determined by this method, does not account for Volta's electromotive force. * * * The latter is in general far greater than that of this article, and is sometimes of opposite sign," etc.

But it is a remarkable fact that Thomson, years after he had pointed out the method which Maxwell approves for determining contact electromotive force, came out (in 1862) with a letter

* "Electricity and Magnetism," § 249.

† *Proc. Roy. Soc. Edin.*, Dec. 15, 1851; *Trans. Roy. Soc. Edin.*, 1854.

giving a "New Proof of Contact Electricity," his famous "divided ring" experiment, in which letter he says, "for nearly two years I have felt quite sure that the proper explanation of voltaic action in the common voltaic arrangement is very nearly Volta's," etc.

I do not feel called upon to take up the cudgels for Thomson or for Volta. The point of immediate interest is that Thomson, after proposing the thermodynamic method of determining contact electromotive force, found it possible to hold a view contradictory to the soundness of this method. This fact may give the rest of us courage to question the finality even of Maxwell's opinion as to the relation between electromotive force and heat in the Peltier effect. I believe, too, that Poincaré, in article 292 of his "Thermodynamique," holds that the opinion supported by Maxwell may be wrong. Let us see what we can do with the question thus raised.

By *difference of potential*, $D_{2\cdot 1}$, between two points I shall mean the net amount of work which must be done because of the attractions and repulsions of electric charges (to use the convenient terms of action at a distance) in carrying unit quantity of positive electricity from point 1 to point 2.

By *electromotive force*, $E_{1\cdot 2}$, along a given path from the point 1 to the point 2, I shall mean

$$E_{1\cdot 2} = D_{2\cdot 1} + i_{1\cdot 2}R_{1\cdot 2},$$

where $i_{1\cdot 2}$ is the current from (1) to (2) and $R_{1\cdot 2}$ is the resistance of the chosen path from (1) to (2).

If either i or R is zero,

$$E_{1\cdot 2} = D_{2\cdot 1},$$

which is practically the case when we have a battery in open circuit, (1) being one terminal and (2) the other, or when we have under consideration two points on opposite sides of a junction of two metals, but exceedingly near together, even if a current is flowing from one to the other.

We have already, looking at Fig. 3, compared the passage of electricity from metal 1 to metal 2 to the evaporation of water in a boiler. Now in this evaporation work of two kinds is done

upon the water, internal work and external work. The movement of electricity across a junction against a difference of potential corresponds to the external work of evaporation. Is there accompanying this movement anything corresponding to the internal work of evaporation? If so, the heat absorbed by the electricity in the movement may be as bad a measure for the difference of potential at the junction as the latent heat of evaporation would be for the external work of evaporation.

It is not absurd to imagine that there may be some change of state of electricity besides change of potential. It is possible that we should take account of something like an attraction between electricity and the metals with which it is associated. Helmholtz imagined such an attraction in order to explain the action of a galvanic cell. Indeed, we are familiar with the idea that attraction or repulsion exerted on the electric charge which ordinary matter may bear is communicated to the matter itself. When the charge on a pith ball is drawn this way or that, it carries the pith ball along with it. To be sure, this phenomenon and others like it may not indicate any fundamental attraction between ordinary matter and electricity. Perhaps they can all be explained by stresses in the dielectric surrounding or penetrating the ordinary matter; but whatever the true agencies may be, they at least simulate attraction or some physical tie between ordinary matter and electricity. We may, therefore, feel free to make speculative use of such attraction.

Our problem is to find, if we can, by use of any reasonable hypothesis, an explanation of the way in which heat drives an electric current around the circuit of dissimilar metals unequally heated.

There are two types of mechanical circuits or cycles operated by heat with which we are very familiar, the steam-boiler-engine cycle, in which the circulation may be practically in a horizontal plane, and various convection cycles, commonly used for heating and ventilation, which may be in vertical planes. In the horizontal cycle we must have valves. Circulation is secured by heating or cooling a fluid which is free to expand or to contract on one side, but not on the other side, the valves being so contrived as to give the necessary freedom and the neces-

sary restriction. In the convection cycle we do not necessarily make use of valves. If the heating and cooling are effected at the right parts of the circuit, gravity supplies the differential force necessary to maintain circulation.*

How can the metals of our thermo-electric circuit take the function of valves or the function of gravitation, and so determine the flow of electricity at the expense of heat energy?

Let us consider first the case of a thermo-electric couple in which neither metal has any Thomson effect, but in which there is a tendency of positive electricity from (1) to (2) at each junction. The thermo-electric force of such a circuit can be accounted for by assuming that metal 2 attracts positive electricity more and negative electricity less than metal 1, and that both these differential attractions increase or decrease with change of temperature of the *electricity*.

At first glance one is likely to think that the differential forces here imagined must increase with rise of temperature, as it may at first seem that the forces at the hot junction must prevail over the opposing forces at the cold junction. But this need not be. The action must be such as to *take in heat at the hot junction* and to *give out heat at the cold junction;* but this condition is perfectly consistent with the prevailing of the attractive forces at the cold junction.

For, consider the analogous case of circulation of water in a pipe circuit made up of two verticals and two horizontals (see Fig. 5). If heat is applied at the proper part of one vertical and if heat is taken away from the proper part of the other vertical, the water will ascend against the force of gravity at the heated place and descend under the pull of gravity at the cooled place. That is, the attractive force, upon the differential action of which the circulation depends, prevails at the place where heat is taken out from the system.

Another analogous case is that of two galvanic cells of precisely the same kind, one cold and the other warm, set to work

* Tait, in the abstract of his *Rede Lecture* which is given in *Nature* for May 29 and June 12, 1873, says that Thomson made use of an analogy between a thermo-electric circuit and the circuit of water in a pipe consisting of two horizontal and two vertical parts. I have not yet found this analogy in Thomson's papers.—E. H. H.

in opposition to each other. If the cells are such that each would grow warm (aside from the development of resistance heat within its parts) by its own direct action, the cooler cell will prevail, and *vice versa*.

So, if the spontaneous action at each junction of our two metals, if each junction could have its own way, would be such as to generate heat at the junction, the cooler junction will prevail when the two are opposed, and *vice versa*.

Now we have rather more reason for expecting, in a given untried case, that the free action of attractive forces will generate heat than we have for expecting that it will absorb heat. Consider, for example, the heat freed as the result of molecular attractions in the condensation of a vapor. Accordingly, if we are to account for a thermo-electric current, in such a combination of metals as we have imagined, by attraction of ordinary matter for electricity, this attraction varying with the temperature of the electricity, we are naturally led to the opinion that the colder junction prevails.

The assumption of such an attraction as we have here imagined, with its dependence on the temperature of the electricity and its independence of the temperature of the metal, except as the temperature of the metal determines that of the electricity within it, is much less violent than it at first appears. If there is such a phenomenon as the expansion of electricity, that is, a diminution of general volume density of electricity, with rise of temperature of the metal containing it, corresponding to the expansion of air or water in the heated part of a convection circuit, this is enough to give just the temperature relation required. For, the lessened volume density of the electricity at the hot junction of the two metals would imply a diminished tendency of the electricity to pass over to the more strongly attracting metal at that junction; but just as there is no tendency of water to flow by gravitation along an unequally heated pipe, if this pipe is horizontal, so there would be no tendency for electricity to flow along an unequally heated homogeneous metal bar, unless the hot parts of this bar attracted a given quantity of electricity more or less strongly than the cold parts. The two metals in which we have stipulated that there shall be

no Thomson effect correspond in our thermo-electric circuit to the horizontal pipes of our imagined convection system; and for the comparison which we are here making it is well to go back to the usual disposition of the thermo-electric diagram, in which unequally heated metals having no Thomson effect are represented by horizontal lines.

Let us now consider a case in which the Thomson effect does play a part, such a case as that illustrated by Figs. 1 and 3. We can, apparently, account for the Thomson effect in any metal by assuming that this metal has a greater attraction for electricity of one sign than for electricity of the opposite sign, and that the difference of these attractions is a function of the temperature of the *metal*. With this condition the electricity of one sign at any part of a homogeneous but unequally heated metal bar will be subject to a net attraction, exerted by the metal, toward a place of higher temperature or toward one of lower temperature, according as the attraction between the metal and this kind of electricity increases or decreases with rise of temperature of the metal; and the other kind of electricity will be subject to a different, greater or less, net attraction from the metal; so that a difference of potential would be set up between the hot and cold part of the bar, if the bar were left to itself.

If we take the view that the electromotive forces which prevail are those at places where heat is given out, we shall in Fig. 3 have the local electromotive force, due to the attraction between metal and electricity, opposite at every place to the electromotive force commonly supposed to reside at that place; so that the unequally heated metals and the hot junction will still conspire against the cold junction; but, as the direction of the current is known by experiment to be that which is indicated by the arrow-points in Fig. 3, we must in this case suppose that *the cold junction prevails over the opposing combination.*

Let us now consider the magnitude of the local electromotive forces. In any case the net electromotive force of the whole circuit is expressed, as we agreed at the beginning, by the area $CC'I'IC$ of Fig. 1 or Fig. 3. But knowledge of the net electromotive force of the circuit tells us little or nothing of the magnitude of the individual four electromotive forces of the circuit.

Ordinary doctrine represents these by the areas, already mentioned, under the lines CC', $C'I'$, etc., in Fig. 3, down to the line of absolute zero of temperature, but as we now undertake to have the electromotive force at the cold junction prevail over the other three, it is evident that we must look for other areas on the thermo-electric diagram to represent these local forces. In this case we find such areas *above* the lines CC', $C'I'$, etc., in Fig. 3, or in Fig. 4, which we will now use in place of Fig. 3.

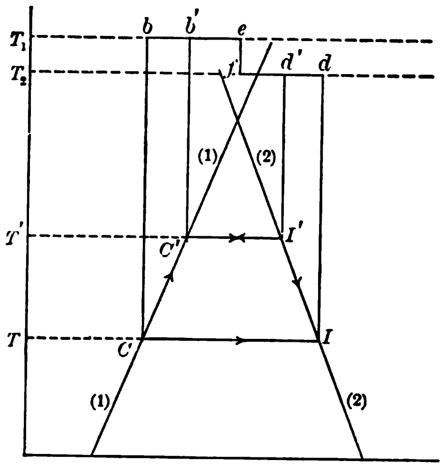

FIG. 4.

Thus the area $Cbb'C'C$, terminated above by the temperature line T_1, characteristic of metal 1, may represent the thermo-electromotive force directed from C' to C in the unequally heated (1).*

Similarly the area $I'd'dII'$, terminated above by the temperature line T_2, characteristic of metal 2, may represent the thermo-electromotive force directed from I to I' in the unequally heated (2). The area $C'b'efd'I'C'$, terminated above by the broken line $b'efd'$, depending on both T_1 and T_2, may represent

* T_1 is apparently the temperature at which the differential attraction of M_1 for the two kinds of electricity becomes zero. A like explanation holds for T_2. [The sloping lines might curve so as to strike the lines T_1 and T_2, respectively, at any angle.]

the thermo-electromotive force directed from I' to C' at the hot junction. Finally the area $Cbb'efd'dIC$, terminated above the broken line $bb'efd'd$, depending on both T_1 and T_2, may represent the thermo-electromotive force directed from I to C at the cold junction. This last, larger than the sum of the others, which oppose it, would be the prevailing electromotive force. The net electromotive force of the circuit would be, as in Fig. 3, represented by the area $CC'I'IC$, and the current would run, as before, clockwise with respect to the boundary of this area.

We have apparently succeeded in accounting for the circulation of the electricity by means of differential attractions conditioned by differences of temperature and in showing that the local electromotive forces of the thermo-electric circuit may be

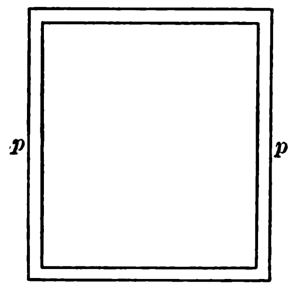

FIG. 5.

opposite in direction to those which are commonly supposed to exist. But we have as yet given no conclusive reason why heat should go in at one part and out at the other, and we have not yet made any attempt to show how heat is used up in the circuit. Our explanation, so far as it has now gone, utilizes difference of temperature but does not utilize heat.

If we return to the consideration of our analogical convection system, we see that, if we were to put in heat at any point p only and take out heat at the point p' only, these two points being on the same level, there would be no continued circulation, as we should presently have the fluid at a uniform temperature all the way over from p to p' and at a uniform, though different, temperature all the way under from p' to p. To maintain circulation we must have the point p, at which heat enters, at a

lower level, and therefore at a higher pressure, than the level and the pressure of the point p', at which heat comes out. The work and the absorption of heat at expansion under high pressure would be greater than the return work and the emission of heat at the lower pressure, and the difference between the inflow and the outflow of heat would be utilized in maintaining circulation against some resistance.

Do we naturally find anything in our thermo-electric circuit corresponding to this heat differential?

We have already assumed that the electricity within each metal acts like an expansible fluid, and it is natural to assume that the rise of temperature which causes the expansion of the electricity absorbs heat. That is, we naturally assume next that there is a real thermal capacity of electricity, or of the corpuscles moving with it, which would come to the same thing. Moreover, we can hardly avoid supposing that the attraction which we have assumed to exist between metal and electricity holds the electricity within the metal in a state of pressure; and accordingly we must recognize in the thermal capacity of the electricity a part accomplished against this pressure in the expansion which accompanies rise of temperature.

Returning, with these additional ideas, to the examination of a thermo-electric circuit showing no Thomson effect, we find that we must in such a case suppose that in each metal the heat absorbed by the current of electricity, positive or negative, which is flowing from cold to warm within that metal is balanced by the heat given out by the current of opposite sign, negative or positive, which is flowing in equal strength from hot to cold within the same metal.

But at the junctions the case is different. At the junction which is the prevailing one, across which each kind of electricity flows from the metal by which its kind is attracted less to the metal by which its kind is attracted more, that is, from a place where the pressure caused by the attraction is less to a place where the pressure caused by attraction is more, each kind of electricity will, without change of temperature, suffer contraction of volume in the transition, and evolution of heat will result. On the other hand, at the other junction, where each kind of

electricity moves, without change of temperature, from a place of high attractive pressure to a place of low attractive pressure, each kind will expand in the transit, and absorption of heat will accompany this expansion.

Thermodynamic considerations show us that in such a case as that which we are considering, in which there is no Thomson effect, heat must be taken in at the hot junction and heat must be given out at the cold junction. Hence our theory, with its later assumptions, assumptions suggested, as others have been, by reflection on the manner and reason of the working of an ordinary convection cycle, has led us clearly to the conclusion that the cold junction should be, in the case considered, the prevailing junction. But thermodynamic considerations go further. They require that the amount of heat, Q', taken in at the hot junction at temperature T', must bear to the heat, Q, given out at the cold junction at temperature T, such a relation that

$$\frac{Q'}{T'} = \frac{Q}{T}.$$

Can we without a straining extension of our assumptions meet this condition? Apparently we can do so by supposing that electricity in its state of compression within each metal obeys the law of a perfect gas. At the hot junction we have the positive electricity going, at constant temperature T', from the attractive pressure p to the attractive pressure $p - dp$, with consequent expansion, work of expansion, W', and absorption of heat equivalent to this amount of work. At the cold junction we have the positive electricity going, at constant temperature T, from the attractive pressure $p - dp$ to the attractive pressure p, with consequent compression, work of compression, W, and evolution of heat equivalent to this amount of work. From the gas law, $pv = KT$, we have, when T is constant,

$$pdv = - vdp = - \frac{KT}{p} dp.$$

This gives us, since p and dp are the same at the hot junction as at the cold junction,

$$W' : W : : pdv' : pdv : : T' : T.$$

And so

$$Q' : Q :: T' : T.*$$

The production of absorption of heat within a single unequally heated metal, the calorimetric aspect of the Thomson effect, is, apparently, easily accounted for without additional assumptions. Thus, according to the theory already stated, the line CC' in Fig. 4 represents a case in which the attractive pressure of the positive electricity is greater at the cold end than at the warm end, while the attractive pressure of the negative electricity is greater at the warm end than at the cold end, of metal 1. Accordingly, positive electricity moving from the cold end to the warm end of this metal will expand more, and therefore absorb more heat, than the mere rise of temperature requires, while the negative electricity in moving from hot to cold within the same metal will contract less, and therefore give out less heat, than the mere fall of temperature requires. That is, to use the conventional mode of expression, the current absorbs heat where it flows from cold to hot in metal 1. For the line II' and the metal 2 the case is *vice versa*.

The conception of electricity, each kind of electricity, as acting within a metal like a perfect gas, seems very revolutionary to one who has been strongly impressed by Maxwell's discussion of the analogy which the behavior of electricity in Faraday's "ice-pail" experiment presents to the behavior of an "incompressible fluid," though Maxwell in pointing out this analogy warns us against being too much influenced by it.

The ice-pail experiment, however, as I understand it, proves merely the difficulty of putting an appreciable excess of either kind of electricity into a given space, a difficulty which still exists after all the assumptions of this paper are made. Consider, for example, the difficulty of putting any considerable excess of positive or of negative ions into an electrolyte. Indeed, the idea of the electric current within a solid as consisting of two oppositely moving perfect gases is so like the familiar and commonly accepted idea of the current in an electrolyte, where we apparently have two oppositely moving bodies of ions, each

* The paragraph ending here makes too easy work of the case in hand.

body obeying the gas law in its osmotic pressure, that, instead of being troubled by the heretical character of this view of the current in a solid, I am somewhat concerned lest I am failing to give due credit to someone who has already proposed it. Of course, Drude in his electron theory does apply the gas laws in some particulars to the electrons within metals, and I cannot be sure that he has not anticipated me in much that is given in this paper, though I did not, so far as I am aware, get from him any of the main features of the theory here proposed.

The question naturally arises, Why not determine the direction and magnitude of the local electromotive forces of the thermo-electric circuit, and so get a decisive trial of the case between the ordinary and the proposed view of thermo-electric action? The reply is that physicists have been trying for more than a hundred years to get a satisfactory determination of a single one of these local forces, the one measured by the true contact difference of potential between any two metals, and have, apparently, not yet succeeded in the attempt. It is the old question of the Volta effect. Some months ago I was of the opinion that Mr. John Brown, F. R. S., of Belfast, had found a way of getting rid of the disturbing effect of the medium surrounding the two metals, zinc and copper in his case, by heating them for several hours in a certain kind of oil. Considerable recent experience with various kinds of oil at the Harvard Physical Laboratory has led me quite unwillingly to the conclusion that the kind of treatment to which Mr. Brown subjects his metal plates may substitute for the disturbing surface condition acquired in air an equally baffling surface condition produced by the action of the oil.*

An attempt to measure directly the difference of potential between the two ends of an isolated unequally heated bar of metal would, apparently, encounter obstacles quite as great as those which have thus far proven unsurmountable in the case

* I do not by this mean to express any doubt that Mr. Brown did get rid of the greater part of the Volta effect, concerning which I am inclined to accept his theory. But, as he mentions a film or tarnish left on both copper and zinc by the oil, and as I find the same, I do not feel sure that the oil has left the metals in a proper condition to exhibit their true contact difference of potential.—E. H. H.

of attempts to measure directly the contact difference of potential between metals. The outlook is, therefore, not bright for any immediate and final answer, on experimental grounds, to this question of the direction and magnitude of the local electromotive forces with which we have been dealing.

I wish to add one afterthought. If electricity flows like a perfect gas through a homogeneous solid conductor of uniform cross-section, its velocity at any given cross-section of the conductor must be, approximately at least, proportional to the absolute temperature of this cross-section. Now the ordinary law of resistance in the case of a fluid moving through small passages is this: Resistance is proportional to the velocity.* Accordingly, we are led to the conclusion that the resistance encountered by our electric stream should be proportional to its velocity, that is, other things being equal, proportional to the absolute temperature at the part of the conductor considered. Now we know that in pure metals this is the general law of resistance, and the fact that this law finds an explanation in a conception of the electric current formed without any reference to electrical resistance adds considerable weight to the argument in favor of that conception.

* This statement ignores two conditions which would hold in the case here imagined, but which would tend to neutralize each other. One is that the friction of a gas increases with rise of temperature. The other is that the co-volume, or space between the molecules of the metal, increases with rise of temperature.

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The Relation Between Air Pressure and Velocity. By Francis E. Nipher. (To be published in the Transactions of the Academy of Science of St. Louis.)

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EXHIBIT OF LIQUID AIR MACHINE IN OPERATION. BY ARTHUR W. GOODSPEED.

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ADDRESS

BY

WILDER D. BANCROFT,

VICE-PRESIDENT AND CHAIRMAN OF SECTION C FOR 1904.

FUTURE DEVELOPMENTS IN PHYSICAL CHEMISTRY.

It has been the custom of the retiring officers to discuss the development of some portion of that field of chemistry in which they were most interested. Since the president of the American Chemical Society will speak on physical chemistry to-morrow night, it has seemed to me that I might break with tradition and discuss the future of physical chemistry rather than its present or its past.

We have reached a critical state in the development of the electrolytic dissociation theory. The work of Kahlenberg has shown that there are a number of facts which we did not anticipate and which we cannot explain satisfactorily at the present time. The recent experiments of Noyes show that the dilution law does not hold for any strong electrolyte and that the same empirical equation describes the behavior of binary and of ternary electrolytes. This last fact appears to be fatal to all explanations based on the assumption that electrostatic effects are the disturbing factors. While the mutual attraction or repulsion of two ions or of three ions may easily change the dissociation formula for a binary or a ternary electrolyte, it is very improbable that the changes will be such as to make two radically different formulas identical. Of course the hypothesis of hydrated ions gives us some leeway but the outlook is not what it was five years ago. It is too soon yet to say whether we are merely to remodel the

electrolytic dissociation theory or whether we are to replace it by something else. My own opinion is that reform is what is needed and not revolution. It is evident, however, that we have gone ahead too fast and that we must test more thoroughly the premises on which our conclusions are based. We know of one error. The proportionality between molecular weight and osmotic pressure holds only for the cases in which the heat of dilution is zero. This is stated clearly in van't Hoff's original deduction of the van't Hoff-Raoult formula $n / N = \log p / p_1$, but has been pretty generally overlooked. Since the heat of dilution is rarely zero in any actual case, our deductions as to the molecular weights of solutes are always somewhat in error. In the case of the metals of the alkalies and the alkaline earths dissolved in mercury, the lowering of the vapor-pressure due to the heat of dilution is practically equal to that due to the molecular weight, and we therefore have the surprising result that the apparent molecular weight is only about one-half the atomic weight. One of the first things we have to do is to eliminate this source of error in all cases.

Another distressing feature in the quantitative physical chemistry of to-day is that the field which it covers is daily growing less. A tenth-normal solution is now considered a concentrated one and some people are so extreme as to maintain that we can not expect agreement between theory and experiment for anything except infinitely dilute solutions. To my mind a theory which holds only for infinite dilution is necessarily wrong. Here again one probable source of error is easy to find. The van't Hoff-Raoult formula is deduced on the explicit assumption that there is no specific attraction between solvent and solute. If this assumption is wrong, it is reasonable to suppose that the error thus introduced would become less as the concentration approaches zero. Under these circumstances the van't Hoff-Raoult formula might represent the facts at infinite dilution without being a true formulation. This is the case with another well-known and important formula. The Helmholtz and the Nernst equations for the electromotive force of concentration cells are identical

for infinitely dilute solutions and for these only. The Nernst equation ignores the concentration of the undissociated salt while the Helmholtz formulation does not. The two equations become identical at the moment when concentration of the undissociated salt and the disturbing factor due to it become zero, that is at infinite dilution. Since the Helmholtz formula applies to all concentrations, the Nernst formula is necessarily only approximately accurate. This has been recognized explicitly by Planck though the point is often overlooked. It is quite conceivable that the shortcomings of the van't Hoff-Raoult formula may be due in part to theoretical inaccuracies and that we have laid too much stress on "variations from the gas laws."

If we introduce the conception of a specific affinity between solvent and solute in certain cases, notably those in which the heat of dilution is marked, we combine all of what has stood the test with what is good in Kahlenberg's conceptions and I believe that we are nearly ready to take a long step forward. One point must be kept in mind, however. Raoult's experiments preceded his formula. Before we can hope to work out a satisfactory theory of concentrated solutions, we must have accurate measurements on concentrated solutions and at present we have practically none. We need experiments at constant temperature on the compositions of coexistent liquid and vapor phases for binary systems with one volatile component and with two volatile components. These measurements are not easy to make and that is one reason why they have not been made. We have measured boiling-points and freezing-points because they are easy to measure; but for a theory of concentrated solutions the value of such measurements is very small. This is because we are then measuring the combined effect of the change of the pressure with concentration and with temperature whereas we ought to study the two separately. Further, if we are to express our results in volume concentrations we must give the volume concentrations of both components. It would be absurd to pass from dilute to syrupy solutions of sugar for instance and to treat the concentration of the water as constant. Person-

ally, I believe that the theory of concentrated solutions is relatively simple and that the difficulties have been chiefly of our own making. My own experience with ternary mixtures comfirms me in this view. In developing a theory of concentrated solutions we must also keep in mind the actual properties of the components, a thing which we have not done in the past. Thus the dissociation equation for liquid chloral hydrate can not be the same as that for liquid chloral alcoholate because chloral is miscible in all proportions with alcohol and forms two liquid layers with water. This is a perfectly obvious fact, yet no reference to it is to be found in any text-book on physical chemistry.

In the last ten years the work of Roozeboom and others has brought the phase rule to the front as a basis of classification and as an instrument of research. The importance of the phase rule is going to increase very rapidly in the next decade. The study of alloys has really only just begun. Our knowledge of the carbon steels is still very incomplete and unsatisfactory. In fact we know the constitution only of a very limited number of binary alloys. Nothing systematic is yet known about the chemical properties of alloys or about the conditions for electrolytic precipitation. The variation of the engineering properties, such as tensile strength, torsional resistance, ductility, etc., with varying concentration and varying heat treatment is a subject which can only be worked out satisfactorily with the phase rule as a guide. On the basis of what has been done it appears quite safe to predict that we do not yet know one-half the possibilities of our structural metals.

Quite recently the constitution of Portland cement has been established and we owe this result to an application of the phase rule. It will not be long now before we get much clearer ideas on the causes of the strength of cements and of the plasticity of the clays. The time will soon come in our engineering schools when the subject known as "Materials of Engineering" will have to be taught by the chemist rather than by the engineer.

The applications of the phase rule to petrography will be

numerous and will come soon. It is evident that no rational classification of minerals can be possible until the constitution of the minerals has been determined. The situation in regard to petrography is much the same to-day as it was in regard to alloys a few years ago and we may reasonably expect as satisfactory results from rocks as from metals. More and more people are experimenting with fused salts, and the new geophysical laboratory at Washington is planning to study igneous rocks in the same thorough way that van't Hoff studied the Stassfurt deposits. The problem is a difficult one experimentally, but it can and will be solved.

The classification of electrochemistry under the phase rule is a problem of the immediate future. Some work has been done already but it is confined to the discussion of the electromotive forces of certain reversible cells. What I mean is something vastly wider than this, the application of the phase rule to all electrolytic and electrothermal processes. Since electrochemistry is essentially chemistry, a classification which is of fundamental importance in chemistry must be equally necessary in electrochemistry.

The extension of the phase rule to organic chemistry is an achievement about which we like to dream, but the realization of it seems far off. To treat a large portion of organic chemistry as a system made up of carbon, hydrogen and oxygen will some day be possible; but at present we are balked by so-called "passive resistance to change." Theoretically methyl ether, $(CH_3)_2O$, and ethyl alcohol, C_2H_5OH, are two modifications of the substance C_2H_6O and they should be mutually convertible. Practically they are not. Only one of the three dibrombenzenes can theoretically be the stable form. Actually, we cannot convert any one of them directly into either of the other two.

In spite of all this there is really quite a mass of material waiting to be worked up. Reversible equilibrium between hydrogen and oxygen can be realized at all temperatures. Reversible equilibrium between carbon, carbon monoxide and carbon dioxide is possible above 200°, while reversible equilibrium between carbon, methane, acetylene, ethane and hydrogen

can be observed above 1,200° without catalytic agents. Carbon monoxide and water react at 430° in presence of copper. Methane can be made from carbon monoxide and hydrogen at 250° in presence of nickel, while methyl alcohol can be changed to carbon monoxide and hydrogen by zinc dust. The decomposition of alcohols into aldehydes, or ketones, and hydrogen is reversible. Aldehydes can be changed into carbon monoxide and paraffines though the reverse reaction has not been accomplished satisfactorily. Methylal and acetal are formed by a reversible reaction, while the ester formation has been studied for years. Formic acid decomposes into carbon monoxide and water when heated by itself and into carbon dioxide and hydrogen when heated in presence of rhodium. Starting from carbon monoxide and caustic soda we can make sodium formate carbonate and oxalate.

As yet only a few of these reactions have been studied with care and we do not know how many of them are reversible or what are the temperature limits. We do not even know whether colloidal metals act more effectively than the pulverulent metals, although it is very probable that they do. While we can not yet tell how far we may be able to go, it is clear that the attempt to apply the phase rule to organic chemistry opens up a most interesting field of research, both as regards organic chemistry and as regards the theory of catalytic agents.

The usefulness of the phase rule in studying basic and double salts is being realized more and more by our friends the inorganic chemists. The recent work on the changing solubility of the hydroxides of many of the metals calls attention to a possibility of error which must not be overlooked. In all cases of hydrolysis there is always a possibility that equilibrium may not be reached in weeks or months. The only safe way is to reach the equilibrium from both sides. In this way and only in this way do we get any clue to the magnitude of the error involved and it is only after we have done this that we are justified in assuming that a reaction is irreversible.

The application of the phase rule to the fractional crystallization of rare earths would certainly lead to marked improvements. There are few people who could separate potassium

and sodium chlorides by fractional crystallization, getting out all of each salt entirely pure. Even fewer would be able to separate potassium sulphate and copper sulphate. In spite of this we start in cheerfully on the fractional crystallization of an unknown number of elements having unknown properties. The result of all this is that we reach a point where further separation is impossible and yet we do not know why. This state of things is really the fault of the physical chemist and not of the inorganic chemist. It is not to be expected that the inorganic chemist can start in off-hand and apply the phase rule to the study of ba ic and double salts or of rare earths. Before this can be done the physical chemist must work out the methods and must be prepared to give explicit working edirections, possibly in the form of recipes.

It must also be clear to you that a study of the conditions of existence of compounds, atomic and molecular, is a prerequisite to any theory of valency.

In the past, reactions in organic chemistry have been studied by physical chemists chiefly as examples of reaction velocity. There are two other fields which will receive more attention in the near future, namely yields and irreversible reactions. The question of yields is in a very bad way. In Lassar-Cohn's admirable book on laboratory methods in organic chemistry there is an enormous amount of valuable material; but there is really very little in the way of theory. Although we know that a reversible reaction will run to an end if the concentration of one of the reacting substances be kept practically zero, surprisingly little use has been made of this principle. We know that certain reactions take place better in dilute solutions or at low temperatures or in certain solvents but in most cases we can not tell why. In the pyridine method for introducing acetyl or benzoyl groups the pyridine is said to be effective because it is a weak base, but it is much more probable that it acts as a catalytic agent. We do not know how far this dehydrating action of certain reagents is simply a question of vapor-pressure or how far there is a specific effect due to the particular reagent. The action of sulphuric acid in the formation of ether is something more

than a dehydrating effect and the same is true of the effect of zinc chloride in the synthesis of ethyl chloride.

A single instance will be sufficient to show the state of confusion that exists. Anschütz's method of preparing certain esters was to saturate the solution with hydrochloric acid gas and to allow the solution to stand over night. Fischer improved on this by adding less acid and by raising the temperature. He boiled for two hours and found that the hydrochloric acid concentration could be reduced to three per cent. without affecting the yield. There the matter is left and we are led to look upon a three per cent. concentration as having special merits, whereas this is undoubtedly merely a result of boiling for the arbitrary period of two hours. If Fischer had boiled for one hour only he would have had to use a stronger acid to have reached equilibrium in the allotted time. If he had boiled three hours, the lowest permissible concentration of hydrochloric acid would undoubtedly have been less than three per cent. Anschütz, on the other hand, worked at ordinary temperature and his solutions consequently needed more acid and more time to approximate to equilibrium. All of this is really first principles and it is only one case out of many. If anyone will try to classify and explain the results given in Lassar-Cohn's book, he will find himself provided with enough interesting research to last him the rest of his natural life.

The second field for research to which I have alluded is that of irreversible reactions. In inorganic chemistry there are as yet no well authenticated cases where a reaction starts and then stops short of equilibrium. The results of Pélabon on hydrogen and selenium and of Hélier on hydrogen and oxygen have been disputed by Bodenstein and must for the present be considered as wrong. In organic chemistry we appear to have many such reactions, typical instances being the formation of nitrobenzene and the decomposition of aldehyde into methane and carbon monoxide. While it is possible that these and other reactions run to an end in infinite time, we have not infinite time at our disposal and it may, therefore, prove profitable to find out whether and how the

apparent end-point varies with varying initial conditions. This work is desirable now and will become necessary if we should ever revise our opinions as to the theoretical possibility of an irreversible equilibrium. By definition we cannot determine the existence of an irreversible equilibrium by approaching the end-point from the two sides. It seems to me probable, however, that we can draw conclusions from the reaction velocity. If we are dealing with a case of a theoretically reversible reaction running to an end, I can see no reason why the concentration of the decomposition products should have any effect on the reaction velocity, so long as we confine ourselves to gaseous systems. If, however, we are dealing with a theoretically irreversible reaction which does not run to an end, the reaction velocity would probably vary with the concentration of the decomposition products.

It should be noticed that it will not do to reason from the behavior of a system in presence of a catalytic agent to that of a system without a catalytic agent, since the catalytic agent may displace the equilibrium. Thus ethyl alcohol is decomposed by heated copper into aldehyde and hydrogen while heated alumina changes it chiefly into ethylene and water. It was the study of organic solutes in organic solvents which led Raoult to the formulation of his law. It seems probable that a study of organic reactions may lead to an entirely new class of equilibria. If this happens, it will throw much light on the preceding problem because it is very difficult to explain some of the peculiarities in regard to yields in organic chemistry so long as we are obliged to postulate reversible reactions only.

The theorem of Le Chatelier has been applied chiefly to heat and work effects; but this is by no means the extent of its usefulness. Wherever we get a reversible displacement of equilibrium by light, it must be possible to make use of this theorem. The change of color of the silver photochlorides is in accordance with the theorem; but there seems to be no reverse change in the dark. The simplest case with which to begin would appear to be the formation of ozone. There seems to be a contradiction here. Ozone is known to absorb ultra-violet light and yet it is believed to be formed by the

action of ultra-violet light. Whether we are dealing with the same sets of rays in the two cases is a point that has not been settled. In fact we do not know definitely whether ozone is formed by the action of ultra-violet light in the absence of electrical waves, though this is a matter easily settled by experiment. We know that ozone gives out light on decomposing but we do not know anything about the spectrum of this light. It is quite probable also that we must formulate the Theorem of Le Chatelier more exactly than we have hitherto done before we can apply it successfully to the phenomena of light. An instance based on electrical phenomena will show what I mean. If a voltaic cell be short-circuited the chemical change will be such as to decrease the electromotive force of the cell. If we do not keep the cell at constant temperature, the Joule heat will cause the temperature to rise and this may either raise or lower the electromotive force of the cell. We are then really considering two phenomena, the electrical and the heat effects. One may mask the other completely.

In one case at any rate we know that we can apply the theorem of Le Chatelier to light phenomena. Suppose we have a gas enclosed in a transparent adiabatic vessel and concentrate upon it light of a wave-length that is absorbed by the gas. The temperature of the gas will rise and equilibrium will be reached when the gas has changed so that it no longer absorbs light of that particular wave-length or when the gas emits light of the same wave-length and intensity as that which is acting upon it. This emission by a gas at some temperature of the light which it absorbs at the same temperature is Kirchhoff's law, which thus appears as a special case of what the chemists call the theorem of Le Chatelier. To be frank I do not now see how we are to apply this theorem to the phenomenon of phosphorescence, and yet we are dealing with an absorption and an emission of light. I venture to suggest that it is to the application of the theorem of Le Chatelier that we must look for a rational treatment of phosphorescence, fluorescence, chemiluminescence, etc., rather than to a theory of vibrating molecules. It will be time enough to discuss

the application to radiations when we have solved the simpler problem of the theory of cold light.

A discussion of equilibrium relations would not be complete without some reference to the future of thermodynamics in chemistry. There are two radically distinct ways of considering the relation of thermodynamics to chemistry. One is to look upon thermodynamics as a mathematical shorthand. The aim of thermodynamics is then to present a consistent and formal treatment of the known energy relations. In this case thermodynamics deals with the past and not with the future; with the classification of knowledge and not with the discovery of new laws. This is the point of view of most mathematical chemists and it is because of this that we do not turn to the mathematical chemist for new ideas. There is another way of considering thermodynamics, namely as an instrument of research. It is not too much to say that the mathematical chemist can work out in a few hours or days results which would take his less fortunate colleague months or even years to obtain. At present the race is to the tortoise and not to the hare; but I cannot believe that this will always be so. Other things being equal, the man who can handle his thermodynamics will beat the man who cannot; but in order to have that take place thermodynamics must be considered as an instrument of research and not as a branch of metaphysics. We must confess that the mathematical chemistry of the past decade has not done what it should have done and that there is no immediate prospect of any improvement. In the meantime we do not despair. There are great possibilities in the application of mathematics to chemistry and some day they will be developed.

So far we have considered problems involving equilibrium only. When we begin to study the conditions which make a reaction possible and which govern its rate, we are brought face to face with our need for a satisfactory theory of catalytic agents. We know experimentally the catalytic action of many substances on many reactions, but we have not even the first suggestion of an adequate theory. This is a subject of more vital importance than mav appear at first sight. I wish

to call your attention to two very important matters which depend directly upon catalytic agents. The first is the chemistry of plants. We can make in the laboratory many of the substances which the plant makes. Some of them, such as alizarine and indigo, we can make more cheaply than the plant can and of a higher degree of purity. As yet we can not make any of them in the way the plant does, and this gap in our knowledge will have to be filled by the physical chemist as the problem apparently does not appeal to the organic chemist. The plant does not use reverse coolers or sealed tubes; it does not boil with sulphuric acid or fuse with caustic potash; it has not metallic sodium and chlorine gas as reagents. The reagents on which the plant can draw are air, water and a few mineral salts. As catalytic agents it has heat, light, difference of electrical potential, enzymes—and itself, namely, living protoplasm. From the work of Bredig and others we know that colloidal metals, the so-called inorganic ferments, can be substituted for enzymes in some cases. As we do not yet know our limitations it is quite possible that we can substitute inorganic catalytic agents for the enzymes in all cases. If that proves to be true we can then duplicate everything except the plant itself, and we shall be ready to determine how closely we can duplicate the reactions of the plant. The experiments of Sabatier and Senderens in France are distinctly encouraging, even though they do not carry us very far. By means of nickel powder it is possible to reduce acetaldehyde to alcohol with hydrogen at 30°. This is the best result that has been obtained and it indicates the possibilities. When we get a satisfactory theory of catalytic agents we shall undoubtedly be able to duplicate many of the plant syntheses and our failures will be interesting as bringing us nearer to the most difficult problem of all—that of life. Pending the development of a satisfactory theory of catalytic agents, there is much to be done in the way of experimenting. In view of the fact that mixtures of two catalytic agents often act more intensely than would be expected from the behavior of each taken singly, it would appear advisable to determine the combined effects of inorganic ferments and ultra-violet light.

The second problem, which would be easier of attack if we had a satisfactory theory of catalytic agents, is that of the transmutation of the elements. This is now admitted to be distinctly a scientific problem, though not one in which we have made much progress. It is usually assumed that it is a very difficult problem. While this may be true, we have not yet reached the point where we are justified in being certain of it. No one has ever attacked the problem systematically and all we can say is that the rate of change has been small under any conditions that we have yet realized. That is not surprising. We should naturally expect a low reaction velocity. The rate of change of radium is so slight that it could not be detected by any ordinary methods. The fact that we have never observed any transmutation of the elements does not prove that none has taken place. We had been making diamonds artificially for years, even for centuries, but nobody thought of looking for them in cast iron until after Moissan made his experiments a few years ago.

If we accept Lockyer's conclusions as to the state of things in the sun, we could undoubtedly break up many of the elements if we could hold them long enough at 6000° C. One difficulty is to get the temperature and of course we must be cautious about conclusions based on simplified spectra. Many people have thought that radium was to be the catalytic agent which was to change all the elements; but the recent work of Rutherford seems to put an end to this idea. If radioactive lead, tellurium and bismuth are merely these elements plus the radium emanation or one of its decomposition products, there is very little evidence to show that any of our well-established elements are undergoing any change from contact with radio-active substances.

Another possibility which has been suggested is that we could change our elements if we could pump energy into them and change their energy content. This would have to be done electrically if at all. I have been told that Stas was busy during the last years of his life trying to change sodium into something else by an electrical process. The difficulty is to pump energy into the element. Passing a heavy current

through a metal produces no effect that we know of other than to raise the temperature. Taking the element in the state of gas enables us to employ a higher potential difference, but here the effectiveness of the method is limited by the appearance of the arc. The first stage in the problem would, therefore, be the attainment of the highest possible potential difference without causing arcing. In view of the remarkable insulating action of gases under high pressure, it seems as though the silent discharge through compressed gases was the thing to try. The difficulties people had in proving the dissociation of water at high temperatures makes us realize the possibility that we might decompose our elements and never know it, owing to the recombination taking place at once. If we are to simplify our elements by pumping energy into them, it appears that we should work with gases under high pressure, with the highest potential difference compatible with the absence of sparking, and with some application of the principle of the hot-cold tube.

While the methods of extremely high temperature and of high electrical stress have much to commend them on paper, they are liable to fail owing to the difficulty of attaining the proper temperature or the proper electrical stress. The ideal method would be to find a catalytic agent which would accelerate the rate of change and which would eliminate what we should then call the instable elements. Since there is no immediate prospect of our being able to predict the suitable catalytic agent and the conditions under which it is to be used, we must ask ourselves what is the scientific method of attacking the problem of the transmutation of the elements.

The answer is a simple one. We must start with the simplest case, study that thoroughly and work up gradually to the more difficult tasks. We should begin with the cases in which we know a change is possible and should study the allotropic froms of the elements. At present our knowledge of these is disgracefully incomplete. We know a little about sulphur, phosphorus, carbon, selenium and tin; but even for these few elements our knowledge is incomplete and it is especially unsatisfactory in matters bearing on the rate of

change. In most cases the change from one allotropic form to the more stable one is fairly slow. It is not even easy to get large amounts of gray tin. On the other hand Saunders discovered, quite by accident, that there were a number of substances, notably quinoline, which convert amorphous selenium into the more stable, black, metallic modification. It is probable that similar results could be obtained with other elements. Kastle has shown that the rate of change of yellow mercuric iodide into the red form varies enormously with the nature of the solvent. The first thing that we need is a systematic study of the allotropic forms of the elements, considering reaction velocity as well as equilibrium. We next take up cases where the change from one form to another can be made increasingly difficult. The three disubstituted benzene compounds, as I have already said, are to be considered as different modifications, only one of which can be stable as solid phase at any given temperature and under atmospheric pressure. According to the text-books *o*-phenol sulphonic acid changes readily into *p*-phenol sulphonic acid on heating. When bromine acts on phenol in the cold, *p*-bromphenol is formed while *o*-bromphenol is formed when the reaction takes place at 180°. I have not been able to find any record of the *p*-brom compound changing into the *o*-brom compound on heating; but the experiment is worth trying. When we come to the three dibrombenzenes, we have a case where we know that the three forms are identical in composition and where there is certainly some sort of an equilibrium at the time of formation because the relative amounts of the modifications can be changed by varying the conditions of preparation. In spite of all this we know no way of converting two of these compounds directly into the third. We could undoubtedly do it if we could raise the temperature high enough just as we could also convert the elements. It is as yet impossible to attain the temperature at which the elements change rapidly, while secondary reactions interfere in the case of the organic compounds. So long as we can not change the two less stable forms of any disubstituted benzene compound into the most stable form, there is no reason why we should expect

to succeed in what may perhaps be the impossible task of simplifying the elements.

Suming up, the future developments in physical chemistry will comprise a theory of concentrated solutions, further applications of the phase rule and of the theorem of Le Chatelier a systematic study of organic chemistry, and a theory of catalysis.

PAPERS READ.

[The following papers were read in joint session of Section C and the American Chemical Society. Meetings were in general session for a small portion of the programme only as the large number of papers and diversity of topics required a division into subsections.]

In General Session.

SOME PRESENT PROBLEMS IN INDUSTRIAL CHEMISTRY. BY EDWARD HART. (Jour. Amer. Chem. Soc., 27, 158.)

RECENT PROBLEMS IN INORGANIC CHEMISTRY. BY JAMES LEWIS HOWE. (Jour. Amer. Chem. Soc., 27, 62.)

REPORTS OF TWO COMMITTEES ON ATOMIC WEIGHTS. BY F. W. CLARKE. (Jour. Amer. Chem. Soc., 27, 177.)

THE ATOMIC WEIGHTS OF SODIUM AND CHLORINE. (To be printed Jour. Amer. Chem. Soc.) BY T. W. RICHARDS AND R. C. WELLS.

THE PRESENT CONDITION OF ANALYTICAL CHEMISTRY. BY W. F. HILLEBRAND. (Jour. Amer. Chem. Soc., 27, 300.)

DIET IN TUBERCULOSIS. BY H. W. WILEY.

PROPER DIET FOR THE TROPICS. BY H. W. WILEY.

THE RIPENING OF PEACHES. BY W. D. BIGELOW AND H. C. GORE. (Bulletin Dept. of Agriculture.)

THE LIBERATION OF HYDROGEN DURING THE ACTION OF SODIUM ON MERCURY. BY L. KAHLENBERG AND H. SCHLUNDT. (By title.)

THE NATURE OF AMORPHOUS SULPHUR. BY ALEXANDER SMITH.

ON THE CONSTITUTION OF PORTLAND CEMENT AND THE CAUSE OF ITS HYDRAULIC PROPERTIES. BY CLIFFORD D. RICHARDSON.

BIVALENT CARBON. BY J. F. NORRIS.

THE NEED OF ACTION REGARDING THE ADULTERATION OF FOODS AND DRUGS. BY LEON L. WATTERS.

Sub-Section.—PHYSICAL CHEMISTRY. A. A. NOYES, *Chairman.*

FREEZING POINT DEPRESSIONS OF AQUEOUS SOLUTIONS OF SOME BENZENE DERIVATIVES. BY E. H. LOOMIS.

THE BEHAVIOR OF THE BRONZES. BY W. D. BANCROFT.

HYDROCHLORIC ACID CONCENTRATION CELLS. BY W. D. BANCROFT

DINERIC EQUILIBRIA. BY W. D. BANCROFT.

ELECTRICAL CONDUCTIVITY OF AQUEOUS SOLUTIONS AT HIGH TEMPERATURES. BY A. A. NOYES AND H. C. COOPER.

ELECTROLYSIS OF CHROMIC CHLORIDE SOLUTIONS. H. R. CARVETH.

THE EFFICIENCY OF CENTRIFUGAL PURIFICATION. BY T. W. RICHARDS AND B. S. LACY. (Jour. Amer. Chem. Soc., 27, 104.)

ELECTRO-STENOLYSIS AND FARADAY'S LAW. BY T. W. RICHARDS AND B S. LACY. (Jour. Amer. Chem. Soc., 27, 232.)

THE MERCURY SULPHOCYANATE COMPLEXES. BY M. S. SHERRILL AND S. SKOWRONSKI. (Jour. Amer. Chem. Soc., 27, 30.)

THE SOLUBILITY OF CALCIUM SULPHATE IN SOLUTIONS OF AMMONIUM SALTS AND OF CERTAIN OTHER SALTS. BY F. K. CAMERON AND B. E. BROWN.

THE ACTION OF WATER UPON CALCIUM PHOSPHATES. BY F. K. CAMERON AND A. SEIDELL. (By title.)

THE ACTION OF SOLUTIONS OF POTASSIUM NITRATE UPON TRICALCIUM PHOSPHATE. BY F. K. CAMERON AND J. G. SMITH

MOLECULAR ATTRACTION. BY J. E. MILLS.

Résumé of papers published in Journal of Physical Chemistry, April, 1901; June, 1904; December, 1904; and of some unpublished work.

ON CROMPTON'S EQUATION FOR THE HEAT OF VAPORIZATION. BY J. E. MILLS. (See Jour. Phys. Chem. December, 1904.)

Sub-Section.—Agricultural, Sanitary, and Physiological Chemistry. WILLIAM P. MASON, *Chairman.*

INTERPRETATION OF A "WATER EXAMINATION." BY WM. P. MASON.

THE WATER OF UTAH LAKE. BY F. K. CAMERON. (Jour. Amer. Chem Soc., 27, 113.)

PURIFICATION OF WATER BY OZONE. BY E. P. BECKWITH.

DETERMINATION OF OXYGEN CONSUMED IN WATER ANALYSIS. BY L. P. KINNICUTT.

STANDARD METHODS TO BE USED IN THE SANITARY ANALYSIS OF WATER. BY L. P. KINNICUTT.

DETERMINATION OF NITRITES IN WATER. BY R. S. WESTON. (Jour Amer. Chem. Soc., 27, 281.)

BIOCHEMISTRY OF SEWAGE PURIFICATION; THE BACTERIOLYSIS OF PEPTONES AND NITRATES. BY S. D. GAGE. (Jour. Amer. Chem. Soc.)

AN APPARATUS FOR RAPID ESTIMATION OF UREA IN URINE. BY F. C. ROBINSON.

A COMPARISON OF ORGANIC MATTER IN DIFFERENT SOIL TYPES. BY F. K. CAMERON. (Jour. Amer. Chem. Soc., 27, 256.)

AVAILABILITY OF NITROGEN IN THE SOIL BY G. S. FRAPS.

HOMICIDE BY ACONITE POISONING AND THE QUANTITATIVE ESTIMATION OF ACONITE IN THE HUMAN BODY. BY H. C. CAREL.

Sub-Section.—Industrial Chemistry. EDWARD HART, *Chairman.*

TURPENTINE. BY W. C. CARNELL.

THE DETECTION OF ROSIN IN VARNISHES. BY A. H. GILL. (By title.)

BEST METHOD FOR THE ANALYSIS OF REFINED COPPER. BY G. L. HEATH.

THE EDUCATION OF TECHNICAL CHEMISTS. BY I. A. PALMER.

THE UTILIZATION OF FINE ORES, FLUE DUST, STOVE DUST, DOWN-COMER DUST, ETC., IN THE BLAST FURNACE. BY J. C. ATTIX. (Jour. Amer. Chem. Soc., 27, 142.)

Sub-Section.—Inorganic Chemistry. JAMES LEWIS HOWE, *Chairman.*

THE EFFECT OF WATER ON ROCK POWDERS. BY A. S. CUSHMAN.

ON THE COMPLEXITY OF THORIUM. BY FRITZ ZERBAN.

ON THE DETECTION OF HYDRONITRIC ACID, HYDRAZINE AND HYDROXYLAMINE IN THEIR INORGANIC COMPOUNDS. BY A. W. BROWNE.

TUNGSTEN HEXABROMIDE. BY F. F. EXNER. (By title.)

NON-EXISTENCE OF COPPER HYDROXIDE. BY ARTHUR JOHN HOPKINS. (By title.)

REACTIONS BETWEEN ZINC AND COPPER SULPHATE. BY ARTHUR JOHN HOPKINS. By title.

NOTES ON THE ABSORPTION OF HYDROCHLORIC ACID AS A BASIS FOR STANDARD SOLUTIONS. BY A. T. LINCOLN.

A NEW BURETTE HOLDER. BY A. T. LINCOLN.

A NEW METHOD OF DETERMINING THE OXYGEN IN THE AIR. BY I. W. FAY.

A MODIFIED WESTPHAL BALANCE FOR USE WITH SOLIDS. BY F. N. WILLIAMS.

REACTIONS IN LIQUID AMMONIA. BY E. C. FRANKLIN.

Sub-Section.—Organic Chemistry: JAMES F. NORRIS, *Chairman.*

LABORATORY INSTRUCTION IN ORGANIC CHEMISTRY. BY JAMES F. NORRIS.

THE DETECTION OF PALM OIL WHEN USED AS A COLORING FOR FATS AND OILS. BY C. A. CRAMPTON AND F. D. SIMONS. (Jour. Amer. Chem. Soc., 27, 270.)

THE DETECTION OF RENOVATED BUTTER. BY C. A. CRAMPTON AND F. D. SIMONS.

A METHOD FOR THE RAPID ANALYSIS OF SUGAR BEETS. BY DAVID L. DAVOLL, JR. (Read by title.)

THE RAPID DETECTION OF BEADING OIL IN WHISKIES. BY O. S. MARCKWORTH. (Read by title.)

DERVIATIVES OF SOME PETROLEUM HYDROCARBONS OF LARGE MOLECULAR WEIGHT. BY C. F. MABERY.

A RAPID GASIMETRIC METHOD FOR THE DETERMINATION OF FORMALDEHYDE. BY G. B. FRANKFORTER AND RODNEY WEST. (Read by title.)

THE ACTION OF PERMANGANATE AND SODIUM PEROXIDE UPON FORMALDEHYDE, WITH A DETERMINATION OF THE HEAT OF COMBUSTION. BY G. B. FRANKFORTER AND RODNEY WEST. (Read by title.)

FIRPENE, A TERPENE AND ITS COMPARISON WITH PINENE. BY G. B. FRANKPORTER AND FRANCIS FRARY. (Read by title.)

THE CRYSTALLINE ALKALOID OF CALYCANTHUS GLAUOUS. H. M. GORDIN. (Read by title.) (Jour. Amer. Chem. Soc., 27, 144.)

THE OIL OF THYMUS VULGARIS. BY W. O. RICHTMAN.

METHYLAMINE AS A SOLVENT. BY H. D. GIBBS. (By title.)

THE HYDROCYANIC ACID CONTENT AND SOME OTHER PROPERTIES OF CASSAVA. BY C. C. MOORE.

SECTION D.

Mechanical Science and Engineering.

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J. B. WEBB, 1 year; H. S. JACOBY, 2 years; H. T. EDDY, 3 years; WM. KENT, 4 years; A. M. GREENE, JR., 5 years.

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WM. T. MAGRUDER.

ADDRESS

BY

CALVIN MILTON WOODWARD,

VICE-PRESIDENT AND CHAIRMAN OF SECTION D FOR 1904.

LINES OF PROGRESS IN ENGINEERING.

The engineering army, like the myriads of well-trained, well-equipped and well-organized soldiers of the Mikado, stretches from high ground to high ground along an extended front, facing the hosts of conservatism who are entrenched behind moats of difficulties, redoubts of prejudices, batteries of tradition and in citadels of ignorance. Like the Japanese, the division commanders, looking well to their supplies of ammunition (*i. e.*, correct theories) and their daily rations (*i. e.*, materials of construction and shop practice), push forward now at one point and now at another, capturing hill after hill, now on the right, now on the left, and now in the center. The army of science never retreats; it forever forces back the frontiers of darkness, and solves problem after problem from the endless list of secrets with which the storehouses of nature are filled.

It is a glorious thing to belong to this engineering army, to rejoice in its triumphs and to share in its rewards. Its success is not accidental; its triumphs are not matters of chance. Engineering blood always tells. Just as we train our best soldiers and sailors at West Point and at Annapolis and as our appliances at military and naval schools keep pace with the arts of war on land and sea; so our schools of engineering, if they are up-to-date institutions, keep pace in the theories they teach and in the laboratories they equip with the best

engineering practice. Every advance at the front (to resume my simile) means an advance of all supplies and in the enlisting and training of recruits. I am by profession a recruiting officer, and I am engaged with my fellow officers in training and equipping men for the firing line and the front rank. That the new material we send forward may be just what is wanted, we must have information as to the progress making and the next points of attack. In short, our schools of engineering must know the lines of engineering progress.

I am well aware that I shall not be able to touch upon many of the important matters which my subject is sure to bring up, and I can not expect to take them in the order of of their importance. Probably no two of us would agree upon their relative importance; one's environment has so much to do with what lies just beyond his horizon; so I doubt not you will supplement my statement with most interesting and valuable suggestions.

THE UTILIZATION OF WASTE ENERGY.

While much has been done and much more is doing at waterfalls and river rapids, large and small, the work of saving the energy which now runs to waste has but just begun. When the great waterfalls are utilized the rapids will remain. We are lost in wonder when we calculate the possibilities. Measure the volumes which rush over the "Sault St. Marie," as the waters of Lake Superior drop to the level of Lake Huron; and then again put your measuring rods into the vastly greater volumes which plunge and rush from Lake Erie to Lake Ontario; and still again through the rapids of the St. Lawrence to the sea level. At every vantage ground, the work of utilization has begun and no man now living will see that work stop. Turn next to smaller streams and mountain torrents—what fields open up to the hydraulic and electric engineers! Mountain reservoirs will serve the triple purpose of preventing destructive floods, of saving the energy for useful work and of aiding irrigation. At every count the doors open wide for the best of engineering enterprise and the best of engineers, hydraulic, mechanic, electric; and the echo of each depart-

ment must be heard in the engineering lecture-room and laboratory. The electric transformer has made the transmission of energy possible from mountain slopes to far cities, and has unlocked bewildering amounts of energy at thousands of poitns deemed hitherto inaccessible. No one can see far into the future, but we all easily see the dawn of a new era of energy saving. The streets of this city may yet be lighted by the energy which now runs to waste at Niagara. In St. Louis we look to the slopes and canyons of the Rockies for our supply of sweet, wholesome water—we may yet look to the same regions for the energy to drive our cars and run our mills.

COMBUSTION ENGINES.

The clumsy steam-engine, with its wasteful furnace, its huge boiler and chimney, is doomed. It has done great work in producing available energy and in wasting still more. It has played a most important part in modern civilization, and it deserves well at our hands, but nothing can stay the decree of progress. Sentence will soon be pronounced, but the day of execution has not been set. I never expect to see the day when steam power plants will cease to exist, but my children will see such a day.

Think for a moment of the present complicated, indirect method of procedure for converting the energy stored in coal into mechanical energy in a moving piston or a revolving shaft. Coal and air are fed into a furnace where combustion converts them into great volumes of a mixture of hot gases. The greater part of the heat and all the volume of these gases escape through the chimney; a small part of the heat only is drawn off by the steel shell and tubes of a boiler and transmitted to a body of water, which is thereby transformed into steam. The steady generation of steam against high pressure, added to its expansion as the pressure is reduced, enables it, when conducted to a cylinder, to drive a piston or revolve a shaft, thereby producing mechanical power. The clumsiness of the operation is equalled only by its wastefulness, which varies from 85 per cent. to 95 per cent.

The problem to-day is: What is the most direct and most

economical road from coal to moving machinery? Engineers are attacking this problem on all sides, and attacking it successfully—gas-engines, and combustion-engines of various sorts bear witness. The future prime-mover will burn (not explode) its fuel in the working cylinder, and the piston will be driven, first by the products of combustion as their volume increases, and secondly by their expansion against a diminishing resistance. I predict great things of the Diesel motor. Originally it was designed to burn powdered coal mixed with hot compressed air; but crude petroleum was found to be preferable. So long as oil flows abundantly from wells, oil will generally be used, but powdered fuel, native or prepared, will doubtless prevail ultimately. The economy and directness of the combustion motor can not be excelled, and when a few years of study and experiment have been applied to the work of simplifying the mechanism (it was a century from James Watt to a triple-expansion Corliss), we may expect it to come into general use for all great central power stations.

The vitality of the steam-engine is due to-day to the mechanical perfection of its design. Its simplicity is marvelous. It is started and stopped with the greatest ease and it almost takes care of itself. The invention of the steam turbine has probably given to the furnace and steam-boiler another lease of life. The wonderful adaptability of the turbine for electric generators is something which was not anticipated.

Will not some one design and construct a combustion engine which shall consume continuously oil and compressed air, thus maintaining a high pressure in a gas chest and driving a turbine with the products of the combustion used expansively as is now done with steam? The proposition is an attractive one, both for the lecture room and for the engineering laboratory. It is sufficient now to call attention to its possibility, and to indicate a point for study and progress.

It will not be amiss for me to quote the figures given me by the engineer in charge of the Diesel engines which drove the generators for power and light in the "Tyrolean Alps" at the late world's fair in St. Louis.

These engines, three in number, of 225 horsepower each,

were the observed of many observing engineers during the seven months of the fair. The assistant engineer in charge kept daily records of the work done, and fuel used, and kindly gave me a sample of his reports. The details are extremely interesting. The work was measured at the switchboard, no allowance being made for loss of energy in the engine, air pump and generator. The total work of the three engines between noon and midnight was 2,768.5 K.W.H. This is equivalent to 3,711 H.P.H.

Total fuel used (Indiana oil), 266 gals.

Fuel per 100 K.W. hours, 9.58 gals.

Fuel cost in car-tank lots, 3c. per gal.

Cost per 100 K.W.H., $0.287.

Cost of the day's fuel, $7.08 or 2.15 mills per H.P.H.

Thus one cent paid for the fuel for one horse-power for four hours, forty minutes.

The three engines worked under about two-thirds of a full load and used three gallons of lubricating oil during the day.

The above figures seem to me little less than remarkable. While still wasteful, as nature measures energy, these engines are several times as efficient as the better styles of ordinary steam-engines. Doubtless they lack simplicity and the certainty of action which comes from experience and close study; but I can not help feeling that the road to the future "prime mover" runs hard by the construction shops of an internal-combustion engine. Let students and professors take warning.

ARTIFICIAL CENTERS OF POWER.

One of the most important openings for future engineering enterprises is the establishment of large power centers, not only where water-power is available, but where fuel is abundant as well.

Take, for example, the vast coal mines in the vicinity of the city of Philadelphia and those in the vicinity of St. Louis. In each case the power for industrial establishments and all kinds of moving machinery, large and small, in use in the city, including the street cars, and the rolling stock on all

roads, can well be furnished by electrical currents from large generating establishments near the mines. Add to the above the establishment of gas works sufficiently large to furnish all the gas needed for illumination, for gas-engines, for heating and cooking purposes in a great city. In the case of St. Louis those gas works should be near the extensive coal mines of Belleville and other coal-producing regions only a few miles from the city.

The effect of these two great steps forward upon the physical and sociological characteristics of a city can hardly be overestimated. The ultimate economy and convenience of such installations are enough to justify them. We have yet to learn how cheaply fuel gas and electric currents can be furnished to large concentrated groups of consumers. But omitting all questions of mere financial economy, what a saving in health, beauty and enjoyment! The London fogs which we hear so much about are produced largely by London smoke, and the prevention of smoke will to a very great extent be the prevention of the fog. I look forward to the day when, instead of a small volcano of smoke from a brick crater above every house, St. Louis will have all its heating and cooking done by gas, and all power will be furnished by electric currents, or by gas and combustion-engines, both gas and electricity coming from the gas works and power plants at the mouths of the coal mines in Illinois. What an era of cleanliness and comfort this presages! This era of cleanl ness will be brought about by the engineers. Hence engineering education must see to it that engineering students are prepared for their high mission. The proposed "Million Club" of St. Louis bears no comparison with a possible "Clear Sky Club." The former proposes to seduce 250,000 non-resident smoke-makers into joining the 750,000 smoke-makers already resident in St. Louis, thereby making smoke enough to shut out the sun entirely (they almost did it during a whole week last November). The "Clear Sky Club," on the other hand, will propose to eliminate all smokers by sending coal burning power plants to the mines, thereby leaving the city so clean and beautiful that 250,000 lovers of pure air, clear skies and

godliness will seek homes among us of their own accord. The elimination of smoke, soot and ashes will make St. Louis absolutely bright and clean, and similar improvements here would go far towards producing the same beneficial results in the city of Philadelphia. Already our cities have, or are making arrangements for, an abundant supply of pure water. This has been and still is a great branch of engineering, and it deserves an important place in our schools of engineering. We must next provide pure air and a clear sky.

These steps forward involve no very great addition to our engineering knowledge, but they give opportunity for engineering enterprises, and they show most clearly how essential co-operation is in such work. Large power plants and extensive gas works require much private capital, unless we fly to the extreme of public ownership. The economic construction of large power plants and gas plants, the laying of pipe lines and an unprecedented amount of electric cables, all or nearly all underground, constitute a great field and furnish great engineering opportunity.

THE PURIFICATION OF RIVERS.

We have nearly reached the limit in river pollution. The public welfare will soon make an imperative demand for a halt. A great city like Chicago shall no longer load with poison a little stream like the Illinois, nor foully pollute a great river like the Mississippi. Let me frankly admit that even the city of St. Louis shall not forever dump and pour its refuse into the Mississippi River.

When the national government takes up the function of guarding every stream from pollution (and no state government can deal effectively with the problem) we shall have a great extension of the sphere of sanitary engineering. The recent discoveries by Dr. George T. Moore, of the Department of Agriculture, suggest the possibility of purifying a polluted stream so as to make it not only clear and sweet, but absolutely free from algæ and all harmful bacilli. The proper disposition of house drainage and the refuse of factories is already a live engineering problem in Europe, and American

engineers must no longer neglect it. The study of diseases and their prevention is forcing its way into engineering schools, as preliminary to extensive engineering practice. Whatever form the solution of the problem may take, it will involve both chemical and hydraulic engineering, and the fundamental principles of both must be carefully laid in our schools.

TUBULAR CONSTRUCTIONS.

In the near future we are likely to make great progress in the construction of rolling stock and moving machinery, as well as in the construction of bridges and buildings.

The adoption of electricity by railroads for all kinds of traffic will result, in the first place, in the disappearance of the heavy locomotive. So long as the locomotive was needed to pull a long train of cars, great weight was necessary, and the weight of railway engines and the strength of bridges have been increasing at a rapid rate. We saw a locomotive at the recent fair at St. Louis, weighing over 200 tons. It was a monster, indeed. Should such locomotives become common, every bridge in the country would have to be rebuilt.

But when each car, whether for passengers or for freight has its own motor and drives itself, the heavy locomotive is no longer needed. Moreover, the car itself should be made as light as possible consistent with strength. Weight is of no advantage to a self-driven car. The bicycle has taught us a great lesson in the art of construction. A maximum of strength and stiffness with a minimum of weight. This already, prevails in girders and bridge constructions. The same principles should be applied in all rolling stock and moving machinery. Tubular axles, tubular spokes, tubular fellies, tubular shafts, tubular everything is to be the law of future construction. All the great steam-engines and propellers already have hollow shafts, and I predict an enormous increase in the amount and precision of hollow steel tubing manufactured and used in the next ten years. The mechanical and material advantage of tubular shafting is easily stated. Thus: (1) If a solid cylindrical shaft be compared with a hollow shaft of the same weight per foot of length, but whose exterior

diameter is n times as great, the strength of the hollow shaft in torsion is $2n - 1/n$ times as great as that of the solid shaft. (2) If only equal strength is required, the solid shaft having one nth of the diameter of the tube, will weigh $2n - 1/n^2$ times as much. For a numerical example: (*a*) A thin tubular shaft four inches in diameter is seven and three-fourth times as strong as a solid shaft one inch in diameter which weighs the same per linear foot.

(*b*) A solid shaft weighs seven and thirty-one thirty-seconds (call it eight) times as much as a tubular shaft of equal strength and four times its diameter.

The ratio of stiffness of the tube to that of the solid shaft is even greater.

At the recent St. Louis fair a prize of $2,500 was offered for the lightest motor per horse-power. Motors up to 100 horse-power were eligible. The prize was not awarded, for the reason that inventors and constructors of motors were not prepared to submit their apparatus to the rigid tests required for efficiency and durability; but the offer was made with distinct intention of stimulating the construction of motors which should be suitable for vehicles where lightness combined with great strength is a desideratum, such as in automobiles and air-ships.

STEEL AND CONCRETE AND CEMENT.

I scarcely need call your attention to the important part which steel-concrete constructions are destined to play in future structures. Originally all important bridges, walls and dams were built of stone, and masonry flourished as a fine art. Arches, groined and cloistered, segmental and gothic, elliptic and parabola, combined to make cathedrals and chapels beautiful, and bridges stately and strong as well as durable. Then came the era of iron and steel, and stone bridges were built no more. Steel trusses, posts and girders took the place of stone walls and granite arches. We are now going back to masonry walls and to masonry bridges, but the masonry is no longer granite; it is concrete reinforced by steel. Evidently the opening for engineering theory and

engineering enterprise is most extensive. The new material is not subject to corrosion, so it will not be eaten up by rust. It is incombustible, and is not easily melted or weakened by heat, and above all it is inexpensive and easily handled. The field is a great one, and both the theory and the practice of steel and concrete combinations enter, or should enter, into the curriculum of every student of civil engineering and architecture. In the Austrian building at the recent fair in St. Louis there was a model of the centering of an arch, evidently steel-concrete, of 80 meters span (262 feet). You will remember that the beautiful and imposing "Cabin John Bridge," built of granite, in Washington, D. C., the greatest stone arch in the United States, has a span of 220 feet.

The recent enormous increase in the manufacture of Portland cement is an indication of the coming demand. It has taken thousands, perhaps millions, of years in the laboratory of nature, to produce the masses of granite and the layers of marble and limestone; the engineer and the chemist, working together, produce from the abundant supplies of material near at hand an artificial masonry in a few hours. Of its strength and durability the engineering laboratory and a brief experience tell us much. The verdict of a thousand years is still to be rendered, but here again the hand of promise points our way.

AERIAL NAVIGATION.

Above I casually mentioned air ships. You must bear with me while I say several things about aerial navigation.

We have been accustomed to regard the problem of practically navigating the air as one which could not be solved, or, at any rate, as a sort of fad hardly deserving of mention in connection with engineering. It will be remembered that the late eminent engineer, Professor J. B. Johnson, would not admit that aerial navigation was a possibility. He classed it with the problem of perpetual motion. But a careful examination of all the conditions seems to me to point towards the possibility of progress, and all that we can at present claim for many desirable improvements is that they admit of progress.

We can not with any confidence predict the rate of progress. Some of the things I have already pointed out bear directly upon the problem of aerial navigation; two in particular: The use of tubular constructions for the maximum of strength and the minimum of weight; and the construction of motors which are strong and light; but many problems must be solved before we can really navigate the air.

It was my privilege to be connected with the discussion of aerial matters at the late fair in St. Louis. Without my knowledge I was selected as the president of the aeronautic congress, in which the problems of aeronautics were carefully discussed. That congress had no functions whatever in regard to aerial exhibits, or attempts to exhibit air ships, at the world's fair. The latter feature of the fair I regret to say was a deplorable failure. The greater part of the failure was inevitable, since aerial experimentation is expensive and difficult, and it has very rarely been undertaken by scientific people. What has been done anywhere in that direction has been for the most part crude, ill-advised and unscientific, and failures have generally attended any attempts to actually navigate the air. Of course, there are exceptions in the character of the investigations made. I could mention four Americans who are approaching the problem carefully and on scientific lines. Some of their investigations and experiments are full of promise for the future of aerial navigation.

So far as the failure of the spectacular part of aeronautics at the fair was concerned, that failure was due very largely to the vandalism of some crazy crank or rival, who cruelly mutilated the air ship brought over by Santos-Dumont at great expense, to be used during the summer in St. Louis; and especially was the failure due to the most unfortunate and unwarranted charge which a police officer made in response to a call for a report in regard to the mutilation of "Santos-Dumont No. 7." Being unable to get any clue to the guilty wretch (who had plenty of time to slip in and slash the gathered silk in hundreds of places while the guard sipped his coffee in a booth a few hundred yards away), and feeling doubtless that he must give some explanation, he actually stated that

in his opinion the injury was inflicted either by Santos-Dumont himself or by some one of his men. No more injurious, unwarranted or insensate charge could have been made, and no person who was in any way acquainted with Santos-Dumont could have made it; and yet that charge became current in the newspapers and was half believed by a great many very respectable people far and wide. Doubtless the currency of that charge did much to discourage and repel Santos-Dumont from our shores. That he should have received such treatment in America was surprising and greatly to be regretted. It went far to give us a bad reputation in European circles. We are credited with hostility towards European inventors and experimenters. I trust Mr. Santos-Dumont may eventually learn that Americans as a rule are fair-minded, generous and friendly towards all experimenters in every field. I trust he may learn that not one, so far as I know, of the gentlemen who were associated with him during his two visits to St. Louis sympathizes in any way or to any extent with the insinuations thrown out against him by the officer above referred to.

From this digression I now turn to the subject in hand, namely, the possibility of progress in the art of aerial navigation. Regarding progress in aerial navigation as entirely possible, I notice that it depends upon the solution of many problems, and no successful air ship can reasonably be expected to appear until these problems are solved.

There are two lines of attack, which, while differing in one respect, have very much in common. Investigators are naturally divided into two classes: One seeking to devise methods for navigating the air as birds do, which gain support and propulsion solely from mechanical and muscular energy; and the other relying for support, more or less, upon the bouyancy of hydrogen gas, while securing propulsion by means of propellers. All are clearly interested in motors, whether the air ship moves with or without the support of a bag of hydrogen. All are concerned with methods of management, and with the adoption of means for directing the movements of an air ship through the air.

If a gas bag is to be used, it is evident that the shape of

the bag which involves the least amount of resistance is of first importance, and if that bag is to be a diminishing quantity, the ship must secure support from the use of aeroplanes or curved surfaces as the craft is driven rapidly forward. It is evident that the character of supporting surfaces and their distribution are matters of first importance in all cases. The number of preliminary lemmas which must be solved before the main proposition is reached is readily seen. The recent aeronautical congress concerned itself wholly with discussions and reports of experiments upon these preliminary matters, and I can truthfully say that excellent work was done.

I spoke of the gas bag as being a diminishing quantity. I wish to add a few words to make my meaning clear. When it was first proposed to propel an ocean ship by means of mechanical power, it was assumed as a matter of course that the ship itself could float upon the water, and that mechanism was to be employed solely for the purpose of driving it forward and for steering it. In aerial navigation the case is different. The ship is not only to be driven forward, but it must be supported. The analogous case, therefore, is not that of an ocean ship, but of a heavy swimmer who must both support and drive himself forward. Swimming does not come to boy or girl by nature, and the skillful teacher furnishes a temporary support while the learner masters the art of using his hands, feet and legs correctly. Accordingly, he applies either a buoyant bag of air between the boy's shoulders, or the gentle lift of a string attached to a pole, and thus supports the learner while he masters the mechanical details of swimming. This exterior lift or support is a diminishing quantity as the pupil progresses, and when correct motions are learned and become automatic, the pupil swims and external aid is no longer necessary.

Similarly, as it seems to me, aerial navigation is to be accomplished. At first the craft may very properly be supported by a bag of hydrogen. Something must hold the structure which is to carry motor, propellers, fuel, ballast, steering apparatus, aeroplanes, etc., above the ground, in comparatively still air, while tests can be made and skill in manage-

ment can be acquired. Infinite patience, plenty of money and first-class engineering culture and skill will be required. The various elements must be studied one at a time, while a friendly gas bag holds the experimenter aloft. When an engineer can build a durable and well-proportioned motor and system of propellers, which shall be as strong as twenty horses and only as heavy as twenty geese; and when he can drive his supporting bag of hydrogen through the air at the rate of twenty or thirty miles per hour, he can reduce the size of his bag and get support from aeroplanes and curved surfaces, and learn to manage them. The smaller the gas bag, the less the resistance of the air; consequently a greater velocity; consequently a greater lift of the aero-surfaces; and again a less demand upon the hydrogen—and so on, to final victory. American skill, ingenuity and experience will triumph provided that experience is cumulative. Men must learn from twenty failures how to succeed the twenty-first time in one thing. As I said: Patience, money and time are necessary. I wish Andrew Carnegie or some other "captain of industry" who is in danger of dying rich, would establish and endow an "aeronautical experiment station and laboratory," and then place it in charge of a physicist like Professor Zahm, and an accomplished mechanical engineer like Mr. Blank. In ten years such men, under such conditions, would go far towards a solution of the problem of aerial navigation.

FUNDAMENTAL PRINCIPLES.

Some one proposed to teach a nation patriotism by writing popular songs for its schools. There was a world of wisdom in the suggestion, for the foundations of character and the guiding principles of life are generally laid at school. That is why, the great teacher is such a power in the world.

Is it not so in engineering? Are not a few fundamental propositions of mechanics what one must fall back upon when a new problem is encountered' And does not the probability of one's seeing new problems and of solving them depend very largely upon one's absolute mastery of those few fundamental propositions? If you agree with me and answer these ques-

tions in the affirmative, then it follows, in our opinion at least, that the lines of progress in engineering will depend largely upon the complete equipment of our schools and the thoroughness with which the basic doctrines are instilled into the life-blood of the students. It is said of Benjamin Franklin that he could not take a walk nor go on a journey without seeing all about him unsolved problems and new illustrations of universal laws; and with Franklin to see a problem was almost the same as to solve it.

MANUAL TRAINING.

I can not close this rambling address without referring to a recent improvement in secondary education which is likely to affect favorably engineering education, and through that education promote the future of engineering itself. I refer to the introduction into high schools and academies of the study of tools, materials and the mechanical processes. At the age of fifteen the expanding boy feels the thrill of increasing strength, and a natural hunger and thirst for contact with material things. The instinct to handle things, to do things, requires guidance or it becomes belligerent and destructive. The material universe is to be solved by every one for himself; if in no better way, it will be by pulling things to pieces to see how they are put together; by breaking things to see how strong they are; and by making new things if he only know how

Then and there are the time and place for manual training; not for a trade or a profession, nor even for fun and pleasure; but for culture and a conscious mastery of tools and materials, and the arts of construction. During the secondary stage of education the student should find himself and get an intelligent insight into the world of mind and matter around him. Both inborn aptitude and external opportunity should justify the coming engineer. The new educational feature goes far to develop the one and to discover the other. The fruit of well-organized and logical manual training is clear thinking, strong, vivid concepts, a world of knowledge gained first-hand, a power and habit of mental analysis of concrete problems —all of which admirably prepare the boy to take up, as a man,

the study and practice of engineering. We have all seen something of this rich fruit, and have tested its value. In my judgment, it bodes well for engineering. Like Franklin, these young men (and they are swarming through our manual training schools and knocking in increasing numbers at the doors of our technical schools and colleges) will see things, and solve things, and make things move. The promise of the future is glorious; splendid is the era now dawning; fortunate in their opportunity are the young engineers with clear heads and skilled hands who are coming to the front; and happy are we who, to the best of our ability, are helping on the higher civilization which good engineering makes possible.

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[*Joint meeting with Section I*].

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ADDRESS

BY

ISRAEL C. RUSSELL,

VICE-PRESIDENT AND CHAIRMAN OF SECTION E FOR 1904.

CO-OPERATION AMONG AMERICAN GEOGRAPHICAL SOCIETIES.

In considering the many ways in which the science having as its special province the study of the earth's surface can be enhanced and its service to mankind rendered more efficient through the agency of geographical societies, five subordinate themes present themselves for consideration. These are: The scope and aim of geography; the methods of gathering and distributing geographical knowledge; the functions of geographical societies; the present status of the geographical societies in America; and in what ways can the geographical societies of this country increase their influence and enlarge their usefulness.

THE SCOPE AND AIM OF GEOGRAPHY.

The proportions of a great mountain seem to vary according to the point of view of the beholder, and the impressions it makes on various minds also vary, as may be said, in reference to their sensitiveness to thought-waves of different length. To the dweller in a vale at a mountain's base, its sublime slopes do not present the same picture that is beheld by the traveler on a neighboring plain; the impressions its weathered battlements awaken in the mind of the untutored savage have but a faint resemblance to the train of thought started into activity by the same stimulus in the brain of the geographer. When the name of the mountain is spoken, all of its attributes and all of its

subjective influences may be conceived as being embodied in the word used.

In a similar way the word *geography* has many shades of meaning, according to the point of view and the training of the person using it. To the child at school, to the poet, the painter, the man of affairs, the scientific geographer, etc., the word does not have the same significance, and in fact, in the different connections just suggested, might be thought to refer to widely different subject-matter. To some persons the mountain of earth-lore is far distant—a mere cloud on the horizon—while to other persons it is near at hand, overshadowing in its immensity, awe-inspiring in its magnificence, and its rugged slopes inscribed with the history of ages, while its summit is veiled from view in the cloud-land of the unknown.

The multiple interpretations that may be given to the word geography demand attention, but in order to learn the scope and aim of geography as a science, we turn to the explorers and investigators who have aided in its development. Answers to the question: What is geography? by several of its learned expounders were summarized by Charles R. Dryer, in a recent address* and a concrete definition extracted from them which reads: *Geography is the science which deals with the distribution of every feature and the environment of every creature on the face of the earth.* The meaning of this crystallized statement is more fully shown in the admirable address referred to by enumerating the several subordinate parts of which geography is the symmetrical whole. These are:

1. The earth as a planet: its form, dimensions, motions and relations to the sun.

2. The land: its outline and relief; the distribution of its surface forms, including streams and lakes.

3. The sea: its outline, depth and contents; the properties and movements of sea-water.

4. The atmosphere: its properties, conditions, and movements and their results as manifested in climate.

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* Charles R. Dryer, What is Geography? An address before the Southern Illinois Educational Council at Carbondale, October 23, 1903, Teachers' Journal, Marion, Indiana.

5. Plants and animals; their distribution.

6. Man: the distribution and movements of peoples; human conditions, industries, structures, and, to some extent, institutions.

While it is no doubt necessary to divide and subdivide the science of the cosmos, both for convenience of study and in order to bring the magnificent whole within the range of human comprehension, the rigid lines established for these and kindred purposes, it should always be remembered, are artificial, and nearly always indefinite. There is no inter-science law, corresponding with international agreements, which fixes their bounds. Every student of nature must feel that he can visit his neighbor's fields without being considered a trespasser, and be at liberty to pluck the flowers of truth growing there without being branded a thief. From the hard, dry formulas cited above—although fully appreciating the logical plan for earth-study outlined by them—I would remove the implied limitations as to space and time and introduce perspective. Not only the study of the distribution of land and water, of plants and animals, etc., at the present day should be free to the geographer, but the many combinations of conditions and processes which have led to the present order of things should come within the range of his vision. The "life-history" of every feature of the earth's surface, and the "life-work" of every process by which those features have been fashioned, together with the changes still in progress, as well as glimpses into the future, are to be numbered among the fascinating problems geography has to present. To the study of the earth's surface, may well be added the light, color, and motions which give that surface its beauty and variety. I would have the geographer feel that the thoughts of a poet greater than Milton, who "with no middle flight intends to soar"—are interwoven with the bare statement that the study of earth includes its form, dimensions, motions and relation to the sun. The picture these words outline in the mind reveals a mighty globe, without visible support, revolving in space, and an orderly ebb and flow of its surface waters, in obedience to the same intangible power of gravity; the silent daily change from light to shadow; the pulse-beat of

the seasons; the advance and retreat of secular changes in each of these orderly revolutions—all this and more, so magnificent, and so inspiring, that it can scarce be thought, much less spoken, is by inheritance the right of the geographer and should not be denied him. The earth, like the wayside flower, has a life-history, and a search for the records of its birth and growth is of interest to the geographer, even if not included in the strict time limits granted him, and he should have freedom to follow his thoughts wherever they lead. Nor is this all; the geographer who no middle course intends to take, must reach out for the sun and all his attending planets, and search the realm of distant space for meteors, nebulæ, star-clusters and cosmic mists, which in any way may aid in interpreting the story of the earth's evolution. So also in the study of the land, the sea, the atmosphere, and the relation of these to life, and to human history, I would bid the geographer remember that the earth's surface is not fixed and rigid, a dead, motionless thing, but ever changing in response perhaps to the fall of a raindrop or an eruption of Krakatoa, and that it is clothed with beauty both of form and color, and whispers with a thousand tongues to the admirer who inclines a listening ear.

What then is geography? The study of the distribution of earth features and of the environment of living things, to be sure, but also the reading of the fascinating story of the development of those features, and a search for the complex antecedent conditions which gave birth to the present marvelously delicate adjustment of life to its environment. Illuminating this temple not made by hands are pictures of the earth-beautiful, and the many charms that are imparted to nature-study by all that is lovely in form and color, and fascinating by reason of sound or motion on the still developing earth's surface with which man's life is linked and of which his body is a part.

GATHERING AND DISTRIBUTING GEOGRAPHICAL KNOWLEDGE.

The chief aim of the geographer being to gain all possible knowledge of the earth's surface as it exists to-day, and of the history of the changes which resulted in the present order of

things, the question presents itself: How is this knowledge to be acquired, and what is to be done with the harvest when reaped?

The popular idea in reference to methods of acquiring geographical knowledge is, no doubt, to traverse unknown lands, make voyages in Arctic and Antarctic seas, and scale mountains never before pressed by human foot. Such enterprises, however, although laudable and commendable in themselves, cannot be considered as the most noble or most fruitful of geographical explorations. Geographical advances are to be made not only by crossing ice-fields and climbing mountains, but by excursions into the realm of ideas as well. A modern phase of the science consists in tracing the successive changes various features of the earth's surface have passed through, and in noting the orderly sequence of events produced by the moving agencies still active in modifying and moulding the earth's features. This search culminates in the study of the relation of life and particularly of man to surrounding physical conditions. While the explorer of new lands gathers facts, the philosophical geographer arranges those facts in orderly sequence, interprets their meaning and deduces from them hypotheses, which have for their purpose the discovery of the laws of nature. It is the formulating and elucidating of these laws which constitutes the noblest aim of geographical science. This philosophical stage in the growth of geography has but recently been entered upon, and is the one which is to claim the greatest share of attention in the future.

From this, as yet not generally recognized, point of view it appears that fresh fields for exploration surround us on every hand. Some of the most important advances in geography yet made can be claimed as the fruits of home study rather than resulting from explorations in new lands, although based on and supported by extensive field investigations.

Illustrations of this thesis are: the base-level idea, which was given concrete shape and stamped with a name by Powell, the important principle embodied in the term geographical cycle, coined by Davis, and the laws of stream erosion, transportation and deposition so admirably formulated by Gilbert. These

and other far-reaching and as it seems universal and everlasting doctrines render transparent the clouds which before shadowed familiar scenes and impart to them new significance. The lands to be explored by the scientific geographer encompass us on every hand, and the sea has only just begun to yield up its secrets.

The gaining of geographical knowledge at first hand, or geographical research, consists, then, of both journeying and thinking, and the two are inseparable in order to secure the highest results.

To the question: What is to be done with the fruits of geographical studies when gathered? I could answer curtly: Give them away. Sow the seeds of knowledge broadcast in the minds of men, with faith that some of them will germinate there and multiply a thousandfold. In the harvest of the future, as we may be assured from the principle termed mutation by biologists, every seed will not have reproduced its kind, but new species will appear and rank among the discoveries of the future.

As to methods of geographical research pertaining to individuals, or combinations of individuals, as in organized expeditions or surveys, and the various ways of publishing the results of such undertakings, attention is here invited to only one phase, namely:

THE FUNCTIONS OF GEOGRAPHICAL SOCIETIES.

Aids to exploration and research.—As shown by the histories of geographical societies and most prominently by the records of the Royal Geographical Society of London, the mother of them all, they have been most sympathetic to the adventurer and explorer, and have aided in many instances not only directly from their treasuries, but perhaps still more efficiently through their influence on legislation, in starting individual travelers on their way and equipping exploring expeditions. Incident to such direct material aid have been more or less successful attempts to train explorers for this work and furnish them with instructions as to ways of conducting it. The word "unexplored" has not as yet been erased from our globes, and many mountain peaks are as yet unconquered; the privilege of assisting in such tasks

is still open to geographical societies, and by some persons may even now be considered as the chief aim they should have in view.

With the change from traversing unknown areas to exploring the domain of ideas, which made geography a science, the sphere of usefulness of the geographical society has been vastly enlarged and new duties placed upon it. Thus far, however, geographical societies do not seem to have awakened to the full realization of the dignity of this new life, and the vast possibilities it opens for their own growth and elevation. It needs no argument to show that it is a duty of a society having the study of the earth's surface for its chosen field, to foster and encourage geographical research in the laboratory and library, in cultivated fields, and amid hills and valleys, just as truly as it is to aid the African explorer or encourage the mountaineer who would scale Mount Everest.

To be reckoned among the functions of geographical societies, is the search for the exceptional man, not only he of strength of limb who can climb mountains, and of great endurance who can brave the perils of ice-fields or tropical jungles, but the man of broad philosophical ideas and logical mind, who can correlate the facts explorers gather, supplement them by his own field-studies, and deduce from them the laws that have governed the earth's development and still control the winds, the streams, the glaciers and other agencies by which the earth's surface is being modified and changed.

The corner-stone of every geographical society should, therefore, be geographical research, under which term systematic endeavor to enhance any branch of geographical knowledge is included.

Diffusion of geographical knowledge.—While an increase in knowledge should be the leading ambition of geographical societies, their greatest activity and chief exertion, as shown by their histories, has been in the direction of spreading or disseminating knowledge already acquired. Activity in this direction is highly commendable and should be encouraged, as it is a most important function; but it is an outcome of research and occupies a lower plane. The means for disseminating knowledge

available for geographical societies, as is well known, are: Both popular and scientific meetings, public lectures, field excursions, joint sessions of two or more societies, international congresses, together with the printing and distributing of journals, proceedings, magazines, etc.

Intimately connected with the distribution of a special kind of knowledge from a given center, is the gathering together at that center the records pertaining to the specific aim in view distributed from other centers. One function of a geographical society is, therefore, to maintain libraries of books, maps, charts, and, also, in these later days, of photographs. Necessitated by this and other functions, is the ownership or control of a building suitable for library purposes, places of meeting, etc.

Individual conferences.—All the functions of geographical societies have not been stated, however, when the aids they offer to exploration and study, and their various means of publication are reviewed. There is an important and wide-reaching influence which results from the personal contact and friendly exchange of ideas and experiences between persons engaged in same or similar lines of work. It is seemingly this phase of the social instinct of mankind, more than any other element in scientific co-operation, which leads to the organizing of geographical societies, and serves to hold their members to a common purpose. The importance and value of the contact of man with man, while dependent mainly on the personalities, breadth of experience, and richness of ideas of the men themselves, is also influenced in a favorable way by an increase in the number, and a widening of the geographical range, of the persons of the same cult who are thus affiliated. In general, it may be said of the gatherings of geographers, and of those interested in their work, that the good resulting increases in more than a simple ratio with increase in numbers and with a broadening of habitat. The trustworthiness of these statements finds support in the success of the several international geographical congresses that have been held, and is illustrated by the results of the recent International Congress of Arts and Sciences assembled at the Universal Exposition at St. Louis.

Awakening interest in geography.—Still another important

function of geographical societies is the influence they exert in awakening and stimulating interest concerning the wonders and beauties of the earth in the minds of the people forming the communities where they are located. By thus catering to the curiosity of people, they may be led to inquire more closely into the aims of geographers. This function is analogous to the process of creating a demand in the commercial world, and is not beneath the dignity of a geographical society. Agencies in this direction and exhibitions of maps, photographs, etc., of countries on which public attention is centered, be it South Africa, or Manchuria; collections illustrating the industries of such countries, or a similar gathering together of antiquities, etc. The most common of such exhibits is the placing on the platform at a popular gathering, of an explorer or traveler, who, it may be whispered in some instances, awakens greater curiosity personally than for the additions he has made to geography.

Influence on legislation.—Among the functions of geographical societies, is also included the influence they exert or should possess in reference to advising legislative bodies concerning the aid they are asked to extend to expeditions, surveys, and research along various geographic lines, in order that public funds available for such purposes may be wisely expended. The recognition of the public importance of several European geographical societies, is expressed in their names. One of the functions of the National Academy of Science of the United States, in which geography is represented, is to advise Congress in reference to scientific matters which have a bearing on legislation or demand legislative enactments. Geographical societies, however, which have no organic connection with governments, may influence their action and lead them to foster and promote geographical work, either directly by means of petitions, or indirectly through the personal exertions of their members, as well as by means of the public press, and in other ways. In the exercise of this function also, large membership and an extensive habitat, greatly enhance the good a geographical society can do, and increases in more than a simple ratio with increase in its membership and the breadth of the region from which its members are recruited.

To summarize: The principal functions of geographical societies are: The encouragement of exploration and research; the holding of meetings for the presentation of information on geographical matters, and eliciting discussion; public lectures; field excursions, etc.; publication of instructive geographical reports, essays, maps, etc.; maintenance of libraries; facilitating personal conferences between men engaged in like explorations or investigations; the stimulating of public interest in matters geographical; and the education of legislators as to the relation of geography to human advancement. Even this suggestive summary does not exhaust the subject in hand; the recognition of work well done, as when a geographical society bestows a medal on an explorer; the assumption of the duties of an executor, as when such a society administers a legacy; the opening of halls for the exhibition of loan collections of various kinds, etc., show that the functions of geographical societies are still wider and more varied than can be discussed at this time.

In connection with this summary, I desire to emphasize the fact, as has already been done in part, that in the exercise of several, if not all its functions, the power of a geographical society to do good and enhance the welfare of mankind increases both with the growth of its ideals and its increase in numbers.

That the importance and influence of such a society of necessity increase with the lengthening of its roll of members, may not be true, but as even the laymen in a society have expressed by the act of becoming members their interest in the ideals for which it stands, and furnish the principal part of the audience to which its professional members address their talks and writings, they furnishing a desirable means for disseminating knowledge, and in this if in no other way, aid in the fulfillment of the tasks geographical societies undertake. The mere fact that persons interested in geography unite to form societies is, in itself, evidence that by means of such co-operation something is gained which is denied the isolated individual, and so far as experience suggests there is no upper limit to the number that can to advantage unite their efforts in this manner.

THE PRESENT STATUS OF GEOGRAPHICAL SOCIETIES IN NORTH AMERICA.

The leading functions of geographical societies, being as all persons will I think concede, the increase and diffusion of geographical knowledge, the inquiry comes home to us: How well are the geographical societies of America fulfilling the purposes for which they exist?

After considerable exploration—analogous to that involved in traversing a new land—but greatly assisted by a recently published paper on the "Geographical Societies of America," by J. Paul Goode,* I find that in North America at the present time there are not less than seventeen societies, associations, and clubs, which have geography in some form as the chief bond which unites their members. A list of these several organizations together with certain data concerning them, is here presented:

List of Geographical Societies.

Name.	Location.	Number of active members	Books and maps in library.	Annual dues	Initiation fee.	Life membership.
Alaska Geographical Society.†	Seattle.	1,200	....	$2.00	....	....
American Alpine Club...........	(Organization incomplete.)	....	....	5.00	....	....
Amer. Climatological Ass'n ...	....	140	....	7.50	$10.00	....
Amer. Geographical Society...	New York.	1,300	40,000 books, 12,000 maps, etc.	10.00	....	$100.00
Appalachian Mountain Club...	Boston.	1,500	2,000 books, 1,500 maps, etc.	4.00	4.00	50.00
Explorers' Club	New York. (Organization incomplete.)	....	....	....	....	....
Geogr'l Society of Baltimore† .	Baltimore.	1,725	....	1.00	....	... .
Geogr'l Society of California...	San Francisco.	?	?	5.00	....	100.00
Geogr'l Society of Chicago	Chicago.	65	....	2.00	....	25.00
Geogr'l Society of the Pacific..	San Francisco.	?	4,872 books, 274 maps, etc.	6.00	....	100.00
Geogr'l Society of Philadelphia	Philadelphia.	537	900 books.	5.00	....	50.00
Harvard Travelers' Club	Cambridge, Mass.	140	....	2.00	5.00	25.00
Mazama Mountain Club.........	Portland, Ore.	100	100 books, 50 maps, etc	2.00	....	25.00
National Geographic Society..	Washington.	3,375	1,500 books.	2.00	....	50.00
Pelé Club..............................	(Organization incomplete)	....	....	....	....	....
Quebec Geographical Society†	Quebec.	200	....	....	....	....
Sierra Club............................	San Francisco.	760	....	3.00	....	50.00

* The Journal of Geography, Vol. II, 1903, pp. 343–350; Vol III, 1904, p. 44.

† Quoted from the article by J. Paul Goode, cited above.

The distribution of the above-named societies, as is indicated in the table, includes in an east and west direction, Boston and San Francisco, and its range in latitude is from Washington to Quebec on the east, and from San Francisco to Seattle on the west. In view of the fact that geography is concerned with the distribution and environment of living things, the narrow belt as measured in latitude inhabited by our geographical societies is suggestive. What are the climatic and other conditions peculiar to this belt of nine degrees, which makes it prolific in geographical societies, while the vast region to the north and a nearly equal extent of land to the south are barren in this particular?

Of the organizations referred to, there are perhaps ten which, as declared by their constitution, and made evident by their work, can reasonably claim recognition as geographical societies; the remainder are of the nature of social clubs, with geographical features, rather than societies having for their leading aim an earnest desire to increase and diffuse geographical knowledge. The combined active membership of what may be termed *bona fide* geographical societies is over nine thousand. This number in itself is significant of a wide popular interest in geographical matters particularly among the people of the United States. The condition next in importance to interest in geography, which leads to the organization of geographical societies is evidently concentration of population. Each of our geographical societies has its home in a large city. It is probable, however, that there are many thousands of people outside the cities in which the societies referred to are located, who would join similar organizations if it were practicable for them to attend their meetings. In planning for the extension of geographical societies in the future this great but widely scattered demand needs to receive serious attention.

As is no doubt familiar to most of my readers our geographical societies have extended important aid to exploration, and in the case of at least two societies, namely the American Geographical Society and the National Geographic Society, the record in this respect is an honorable one.

In reference to aid extended to geographical research, when

not directly associated with or forming a part of the work of an expedition, I have inquired in vain for evidence that our societies have either expended money directly or by awarding medals or by other similar means recognized the labor of those who have striven diligently and successfully to explore the domain of philosophical geography.* Here again an extensive field for enlarging the usefulness of our societies makes itself manifest. As shown by a considerable body of evidence that has been gathered, and as is a matter of current knowledge, the greatest efforts our societies have made have been in the direction of disseminating geographical information and attracting popular attention to the results explorers and travelers have brought home. During the year 1903 our geographical societies, clubs, etc., held a total of over 60 home meetings, in part scientific and in part popular; conducted not less than 44 public lectures, and engaged in about 16 field meetings. In addition to these direct methods of spreading information, mostly by addresses and lectures, our societies publish on an average approximating 2,000 octavo pages of printed matter each year. These statistics certainly make a favorable showing, and furnish hopeful signs by which to judge of the possibilities of the future.

The net results just referred to, however, pertain to quantity, not quality. The quality of the work our geographical societies are doing is difficult of even approximate determination, since there is no generally accepted standard of measurement available. This is also a delicate matter to discuss, for the reason that local pride and personal ambition are involved. Certain general conclusions, in this connection, however, seem too evident to be in danger of challenge.

The quality of a popular lecture may be said to be good, when its theme is entertaining and instructive, its presentation clear and forceful, and so adjusted to the audience addressed as to hold its attention and lead to logical and consecutive thought concerning the ideas presented. Since a popular lecture has

* An exception should here be made in recognition of the Elisha Hunt Haner Medal of the Geographical Society of Philadelphia, founded "For encouragement of geographical research."

for its principal aim the dissemination of knowledge, its success depends in a large measure on the number of persons who hear it. Judged from this composite standard, the lectures delivered under the auspices of our geographical societies must in general be adjudged good and their influence wide reaching.

The quality of a scientific session of a geographical society for the purpose of presenting and discussing the results of exploration or the conclusions obtained by painstaking research, may be said to be good when the subject-matter is a contribution to previous knowledge. Added to this quality there should be intelligent and suggestive discussion, bringing to the front various points of view, and showing incidentally whether or not the principal speakers have presented their ideas clearly and logically. The success of a scientific meeting is also to be judged, to a considerable extent at least, by the number of persons in attendance, since one aim and in general the main desire is the diffusion of knowledge. Judged by these standards the meetings of our geographical societies must be accredited with having added important truths to the world's store of knowledge and to have exerted a beneficent influence on thought and methods of thinking. In large part, however, the degree of success in the case of the meetings in question has been less than could have been desired owing to the small measure of encouragement extended by our geographical societies to research, lack of adequate preparation on the part of the audience, and as an element necessary to the dissemination of knowledge, the smallness of the assemblies usually in attendance when questions bearing on scientific geography are discussed.

Success in the case of the publications of geographical societies lies mainly in two directions, one the importance of the additions made to knowledge, and the other the extent to which knowledge is distributed. The pages printed are in the main either popular or scientific, but the highest ideal, as I think may justly be claimed, is attained when both of these properties are combined in an individual production. Enhancing the value and usefulness of the publications referred to, is their degree of perfection as books, the facility with which they can

be had for reading or reference, and the wideness of their distribution.

Turning to the publications of our geographic societies with these ideas in mind, we find less ground for congratulation than in reference to the lectures and the meetings held under their auspices. Without attempting to illustrate by specific examples, it can I think be claimed by an impartial critic that the publications of our geographical societies, when judged as attempts to popularize geographical knowledge, in general lack literary merit, are merely descriptive and do not consistently and with subtlety of purpose lead the reader on to think for himself. As contributions to geographical research the publications referred to clearly contain a few papers that are direct and first-hand additions to science, but the number of such papers is few. Our leaders in geographical research do not as a rule seem to consider the publications of our geographical societies favorable places for putting their results on record.

In reference to the publications under consideration, as specimens of the book-makers' art, they, as a rule, fall below the standard of the better class of literary magazines. Their appearance is in general not attractive, the illustrations in many instances have not been wisely chosen, and, in general, have been poorly reproduced.

As to the distribution and accessibility to the publications under consideration, it is evident that they are not widely known, and although exchanged with scientific societies in this and other lands, they do not find their way into public, collegiate, and private libraries to the extent that could be wished. In part, this lack of what may be termed efficiency comes from the comparatively large number of journals, magazines, proceedings, etc., issued, the lack of demand for the kind of information they contain, and the fact that they are too weak to win their way and attract readers in the face of the competition of scientific writings printed in more attractive and convenient forms. In brief, the efforts of our geographical societies in the direction of publication are widely scattered, in large part the bulletins, etc., issued appear at irregular intervals, are repellant rather than attractive in dress, and in large part are weak when con-

sidered as either literary or scientific production, and do not attain the standard that may reasonably be demanded.

As a summary of the defects of our present system I venture to insist that our geographical societies are not only lacking in unity of purpose, but are antagonistic rather than co-operative. Their influence in each case is local, and their aims narrow and ill defined. In no case has research, the true foundation of geography as a science, been made a prominent feature, and never, so far as I have been able to learn, has it received direct financial aid or popular recognition. Owing to the local character of the societies in question and the narrowness of their respective habitats, the facilities they furnish for men to become acquainted with their fellow workers are much less than could be desired. But the most glaring failures are evident in the general weakness of the publications issued, and the inefficiency of the means employed for their distribution.

This unsatisfactory but perhaps somewhat biased summary brings me to the last subdivision of my theme, namely, the inquiry—

HOW CAN THE EFFICIENCY OF OUR GEOGRAPHICAL SOCIETIES BE ENHANCED?

The chief defects in the present status of our geographical societies being as it appears lack of co-operation, low standards in reference to geographical research, and inefficiency in publication, efforts at improvement should be mainly in these directions.

The proposition has been made that by organizing a strictly scientific society with geographical or, as it seems, more precisely physiographical research as its chief aim, membership to be restricted to what may be termed professional geographers, all that can be hoped for in the direction of assisting in the study of the earth's surface in this country by means of such co-operation might be attained. It is at once apparent, however, that such a course would be the adding of one more to the already long list of American geographical societies, thus tending not only to render still more diffuse the amount of energy available

for geographical work, but to eliminate the more advanced students of geography from the existing geographical societies, and thus deprive them of the leaven, as it were, which is essential to their progress. The new society having research for its chief end, could not be expected to make exertions in the direction of popularizing geography, and thus aiding in the diffusion of geographical knowledge which is the chief purpose of many of our existing geographical societies. It can be reasonably claimed, I think, that a geographical society will attain the largest measure of success when it carries on the work of adding to geographical knowledge and the task of popularizing and distributing such knowledge at the same time, as one branch of the operation assists and stimulates the other. Then, too, the proposed society, having research in geography as its chief function, and not being open to non-professional geographers, would, of necessity, be small in numbers, and the expense of maintaining it would fall entirely on geographical investigators whose financial resources, as is generally understood, are meager.

It may also be mentioned in the above connection that the Geological Society of America welcomes technical papers pertaining to most geographical subjects, and will give them a place in its Bulletin. Similar courtesies are also freely extended by The Journal of Geology and several other scientific periodicals. This greatly lessens the demands of skilled geographers for opportunities to make their results known.

Another plan which contemplates the reorganization of our geographical societies, providing it can be satisfactorily adjusted to the interests of all concerned, has for its chief feature the union of all the geographical societies of North America with the oldest in the list, namely, the American Geographical Society. Under this plan each society effecting such a union would become a chapter of the home society but retain its own organization and its own property, but unite with the parent society in holding annual meetings and in publishing a monthly magazine. This plan has many commendable features when followed out in detail, and differs but little in its aims from the alternative plan which is proposed below. The general bearings of each of these schemes for enhancing the welfare of our geographical science will be considered later.

The alternative plan just mentioned is for the several geographical societies now in existence, and such other similar societies as may be organized in North America, while retaining their individual names and autonomy, to unite in a brotherhood of societies to be designated by some appropriate name, as for example, *The League of American Geographical Societies*, which should provide for one general meeting or congress each year, at such centers of geographical interest as may be decided on, and assume the duty for publishing for all of the affiliated societies. Suggestions more in detail which point the way for securing such co-operation are here presented, it being understood that the first step would be the holding of a convention, at which representatives of each society which might desire to join the League should be present and assist in framing a constitution and by-laws.

A preliminary plan for the organization of such a League as just suggested can at least be outlined at the present time and be made a subject for discussion.

Let the president of each affiliated society be *ex officio* a vice-president of the League. Let each affiliated society elect a member of the council of the League for each 500 of its members in excess of 1,000. Such counselors, together with the vice-presidents, to elect each year a president, secretary, editor and treasurer from the members of the affiliated societies not of their own number. The president, vice-presidents, secretary, and elected counselors to constitute an executive council for transacting all business relating to the management of the League.

The functions of the League would be the holding of an annual congress open to all the members of the affiliated societies for the purpose of reading and discussing papers, etc., and the publishing of a monthly magazine or other journal to take the place of the publications previously issued by the several affiliated societies. The expense of each annual congress to be borne by the members in attendance, and the cost of the magazine to be shared by the affiliated societies in proportion to their active membership.

The executive council referred to should have the power to

receive into the League additional societies as it sees fit, and to arrange for the enrollment of members who are not on the lists of any affiliated society.

Under either of the plans just proposed, namely, a union of various societies in one American geographical society, or a league of societies, the leading advantages to be expected are such as would flow from, 1st, an annual congress of American geographers in addition to our present local meetings, and 2d, concentration of publications.

1. The advantage of an annual congress as may be predicted would be large audiences with wide geographical representation, favorable opportunities for personal conferences and the cementation of friendships, and the encouragement that large and representative gatherings would extend to explorers and investigators to present the best fruits of their labors. To these gains should be added the stimulus such a congress would have in the home cities of the affiliated societies, at which sessions would be held, thus tending each year in an important way to extend the influence and enlarge the membership of some one local society. The greater influence on legislation to be expected from the combined voices of many societies over the efforts of any single, local society, suggests a practically new field of usefulness to the geographers of America.

The chief objections that arise in reference to holding an annual congress of American geographers are two in number: First, the large number of similar meetings now held each year, with which many geographers are more or less closely identified. Whether it is desirable to endeavor to promote still farther this plan of scientific development is indeed a serious question, and one that calls for discussion. The second objection is, that owing to the wide geographical dstribution of our geographical societies, the proposed annual meetings would be but meagerly attended by the members of the affiliated societies located at a distance from the chosen place of meeting. Owing to the conditions existing, there would no doubt be a tendency to divide the annual congress into two sections, as has been done in the case of the Geological Society of America; one to hold its meetings on the Pacific and the other on the Atlantic coast.

Such a division would lessen the influences for good, for which the congress would be organized, and demands careful consideration.

2. The gains to be expected from a concentration of publications are, to a marked degree, expressed by the fact that the proposed magazine, in case all of our geographical societies united in its support, would start with a circulation in excess of ten thousand, not including libraries or subscribers not members of the affiliated societies. With such a vigorous start rapid growth and a constantly widening influence for many years to come may reasonably be predicted. In the list of advantages is to be mentioned also the desirability of having a large body of correlated information in one series of volumes, instead of in many series, thus securing ready reference, and conferring a blessing on future generations of geographical workers. Perhaps the greatest gain to be hoped for, however, is in the direction of a higher tone and better preparation, that a widely recognized, well edited, well printed and well illustrated magazine would have over the for most part obscure and indifferently printed proceedings, journals, magazines, bulletins, etc., now issued. Another and important advantage which the proposed magazine would have over several of the publications which it would replace, would be the securing of the services of a competent editor, who should receive adequate compensation for his labor. Again, it may reasonably be expected that an attractive geographical magazine would replace to a considerable extent the popular literary magazines of to-day, and secure a large number of readers outside of the societies from which it derived its main support. A magazine having for its aim the diffusion of all branches of geographical knowledge, would be welcomed by tens of thousands of our school teachers and other intelligent people in isolated communities who are debarred from oral instruction by leaders in geographical exploration and research.

In reference to the financial aspect of the proposed scheme, it seems self-evident that at least as great a sum of good as is now attained could be secured at less expense, since duplication of reviews, news items, lists of new books, maps, etc., and, to a con-

siderable extent, of matter contained in leading articles could be avoided; and, also, because one editor would take the place of several editors. Again, the new magazine, by having a wider circulation than any one, and, as may reasonably be expected, in excess of all the publications it would replace, would be enabled to secure an important revenue from advertisements.

One reason for the failure of our present geographical publications to secure a wide circulation outside the immediate members of the respective societies issuing them is, as it seems, lack of business management, coupled with the fact that the enterprise in hand in most instances is too small to be worth energetic exploiting. The publications referred to are not brought before the public in the manner in which literary magazines are promoted, or advertised in the various ways familiar to book publishers. With the proposed concentration of publications there would also be a concentration of effort in the direction of marketing the products of the several affiliated societies, which all persons interested in the matter must agree could not fail to be far more efficient than the present method, or rather want of method, in that direction. In this connection, it may be suggested that some plan for having the proposed magazine issued by an influential publishing house demands careful consideration.

An objector to the proposed plan of concentrating geographical publications may, perhaps, say that the standard of the new magazine with its world wide field and high aims, would tend to discourage the modest student who has his maiden paper to present, and could not afford space for the ambitious amateur who desires to see his name in print. For one, I would meet these objections by admitting their truthfulness, but claim that in the end good would result. The new magazine should be under rigid censorship, in reference to the scientific quality and literary merit of the matter presented. While these safeguards would demand greater care and more serious effort than at present on the part of contributors, they would not debar any one whose work had merit, but serve rather to stimulate all geographers who desire to put the results of their labors on record to strive for high ideals.

From the point of view of the existing geographical societies, it may be claimed that they have developed in response to certain local demands, are adjusted to the conditions that gave them birth, and serve the communities in which they are located better than could be expected if they were more or less merged in a larger organization. Such contentions are no doubt true except perhaps as to the validity of the last clause. The proposed change does not require of any local society or club the obliteration of its individuality. Under the plan for uniting all or a large number of our local societies in one truly American geographical society, there would, of course, be a change of name. If a League were organized present names could be retained and simply another process of publication initiated. The aim in either case should be to maintain the individuality of each affiliated society, and an endeavor to make it if possible even better adapted to local needs than at present. An important aid in this direction (as already suggested) would result from the influence of the general meetings that would be held at the homes of the various chapters or affiliated societies. Such meetings as may be judged from the history of the American Association for the Advancement of Science, would stimulate interest in the local chapters to a high degree.

Then, too, a strong, well written and well edited and well illustrated geographical magazine, by presenting a wide view of geography and of its many contacts with other interests, may reasonably be expected to exert a wider influence even in the home city of an affiliated society than any strictly home journal.

In addition to the richer harvest to be expected from an annual congress of American geographers and a jointly published magazine as just considered, earnest and active co-operation among our geographical societies, as may reasonably be expected from such concentration of energy, should lead to their taking the initiative in several other directions. Among such hopes of the future is the securing of a map of North America on a scale of 1 / 1,000,000, as a contribution to the map of the world in the completion of which certain European societies are interested. Another desirable undertaking would be the publication of detailed instructions for the use of travel-

ers and others, as to how and what to observe, in reference especially to the securing of the best possible illustrations of the results of known physiographic processes, and the recording of facts which are likely to lead to the discovery of new laws. Again, time and money might well be expended in preparing and publishing a dictionary of geographical terms; a bibliography of geographical literature; in assembling a library of photographs particularly of regions where geographical changes are most active, and in yet other directions.

Beyond the immediate and individual interests of a geographical society, or, what is more strictly true, perhaps, in most instances, the personal ambitions of a few of the members of such a society is the broader and nobler aim of increasing man's knowledge of his dwelling place, and of widely diffusing such knowledge. In order to cultivate this larger field, the local society may reasonably be asked to relinquish, if necessary, some of its local prerogatives and look for compensation in the general advance that would be facilitated thereby. Among such restrictions the fact is to be recognized that should a society cease to publish directly, its returns from an exchange of publications with other societies would cease. Compensation for such losses might perhaps be looked for in a decrease of expenses for editing and printing, and might be made good by placing all the "exchanges" received in return for the proposed magazine in the custody of some one society and thus striving to maintain one complete geographical library, which could be consulted directly, or its books, maps, etc., loaned to individual students.

In proposing the application of modern business methods in the concentration of geographical factories, as our societies may be termed, I wish to direct attention to the fact that geography more than any other science is best adapted for the purpose of general or popular education. Added to the fascinations of exploration we now have the equally absorbing results of scientific physical geography, pertaining to the fields through which we walk, the brook whose murmurs have appealed to us since childhood, the waves that beat on the shore where we perhaps spend our vacations, and many other equally familiar

scenes. The ability to read the history of the earth at first hand should be within the reach of every civilized man, woman and child. It is in order to secure to all the people in North America this means of public education, coupled with never ending pleasure and a constantly expanding mental horizon, that our geographical societies are asked to unite their efforts.

PAPERS READ

THE STRUCTURE OF THE CENTRAL GREAT PLAINS. BY N. H. DARTON.

TYPICAL DESERT DEPOSITS OF EASTERN PERSIA. BY E. HUNTINGTON.

THE MENACE TO THE ENTRANCE OF NEW YORK HARBOR. BY LEWIS M. HAUPT.

THE SUBMARINE GREAT CANON OF THE HUDSON RIVER. BY J. W. SPENCER.

INTERPRETATION OF CERTAIN LAMINATED GLACIAL CLAYS, WITH CHRONOLOGIC DEDUCTIONS. BY C. P. BERKEY.

EARLY INTERPRETATIONS OF THE PHYSIOGRAPHY OF NEW YORK STATE. BY ALBERT PERRY BRIGHAM.

THE FOSSILIFEROUS BEDS OF SANKATY HEAD, NANTUCKET, AND THEIR AGE. BY MYRON L. FULLER.

ON THE IMPROBABILITY OF THE EXISTENCE OF LAND IN THE VICINITY OF THE NORTH POLE. BY J. W. SPENCER.

ON THE JAGERSFONTEIN TIFFANY (EXCELSIOR) DIAMOND, WEIGHT 971¾ CARATS. BY GEORGE FREDERICK KUNZ.

ON SOME PEGMATYTE VEINS OF CALIFORNIA. BY T. C. HOPKINS.

THE PETROGRAPHY OF BELVIDERE MOUNTAIN, VERMONT. BY V. F. MARSTERS.

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ZOOLOGY.

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ADDRESS

BY

E. L. MARK,

VICE-PRESIDENT AND CHAIRMAN OF SECTION F FOR 1904.

THE BERMUDA ISLANDS AND THE BERMUDA BIOLOGICAL STATION FOR RESEARCH.

I feel a certain hesitancy in speaking on the subject I have selected to talk about—the Bermuda Islands—because of the number of prominent naturalists who have written so excellently about them. It should be stated at the outset that I do not aim to add to the stock of our knowledge about the Bermudas. So much has been written about their zoölogy in recent years,—especially by the zoölogists of the Challenger Expedition, then by Professor Heilprin of this city, on the invertebrates and the coral reefs, by Mr. Agassiz, incidental to his studies of the great question of the origin and growth of coral reefs, and most recently by that veteran in systematic zoölogy, Professor Verrill, of Yale University,—that it is hardly to be expected that anything fundamentally new will be soon added. It is my purpose, rather, to give something of a picture of the present conditions in Bermuda, based partly on my own experiences, and particularly to direct your attention to the accessibility of the islands and their availability as a place for carrying on intensive rather than extensive researches. With the facilities for work which will soon be provided by the Colonial Government, it should be an attractive place not only for temporary exploration and summer study, but also for protracted investigations on important biological problems.

My own interest in Bermuda as a place for zoölogical study was first awakened by suggestions of President Eliot, who a few

years ago passed the winter in Bermuda, and upon his return inquired of me if I did not think it would be a good place for a marine laboratory. The more I inquired into the conditions of living in the islands, and the marine organisms in the sea about the islands, the more I became convinced of the practicability of the place for a biological laboratory.

At the risk of saying much that is already familiar to many of you, I will give an account of some of the things which seem to me of interest in this connection.

From fifty to sixty hours' steaming brings one from New York to Bermuda. It is worthy of note that the distance of the islands from New York or Boston is only about two-thirds that of the Dry Tortugas or the Bahamas. The climate and the conditions of life in the Bermudas are safe and agreeable at all seasons of the year. Though the humidity is considerable, the temperature in summer rises to only 85° or 86° Fahrenheit; in winter it seldom gets below about 50°, and never to the freezing point. To the zoölogist familiar with the animals of our north Atlantic coast and the water they live in, the waters that wash the shores of these islands and the brilliantly colored animals that inhabit them are a source of surprise and delight.

Leaving New York a little before noon on a Saturday, the islands are usually sighted about mid-day on Monday, and landing is made in Hamilton a few hours later. If one has pictured to himself low-lying coral islands fringed with palm trees, he will be disappointed, and will be surprised to find that the land rises in many places to a considerable height,—even to two hundred and fifty feet or more,—and on approaching nearer to see, instead of palms, the dark green of the cedars that cover many of the hills. In passing from the deep waters of the Atlantic to the shallower depths near land, the dark blue of the ocean is replaced by livelier tints, in which greens predominate, and when the conditions of sun and sky are favorable, the variety of colors exhibited is truly wonderful. Even the far-famed Bay of Naples does not afford a more brilliant display of colors than is sometimes seen in the waters around the Bermudas.

In contrast with these fascinating, kaleidoscopic effects of the sea, the land presents either the dull gray appearance so com-

mon on the granite shores of New England, or the dark green of the cedars, which also reproduce the effect of the New England evergreens. If one could ignore the colors of the sea, he might easily imagine, as he steams along the northern shores of the Bermudas, that he was skirting some part of the Maine coast. One thing, however, would impress him as strange—the brilliant white specks and patches which here and there dot the hillsides or are clustered into larger or smaller groups—the limestone dwellings of the Bermudians. These, with their white roofs brilliant in the sunlight, are in marked contrast with anything to be seen on the Maine coast. Government House on Mount Langton—the residence of the Governor of the islands—is a conspicuous building on the crest of the ridge which hides the city of Hamilton from the approaching voyager.

After a long and rather circuitous course through the only channel available for steamers, and under the guns of several forts, one at length enters Hamilton Harbor between two rocks that are not far enough apart to allow the passage of two ships abreast. The still unfinished cathedral, two modern hotels for the accommodation of winter tourists, and the parliament house are the most conspicuous buildings in Hamilton, being situated on the highest part of the slope occupied by the town (fig. 1).*

The substantial city dock, with its low, unattractive sheds roofed in by arched and corrugated metal, extends along the whole water front. Beyond the sheds runs Front Street (fig. 3) parallel to the shore. Across the street from the sheds are the chief business houses of the town. Some of them have a modern look, but the greater part of them have small windows and heavy solid wooden shutters that recall the northern country store of fifty or seventy-five years ago. Unlike the country store, however, the Bermuda store has a two-story portico extending out over the side-walk, so that the pedestrian is partly sheltered by it from the heat of the sun or the sudden downpour of the unannounced shower that is so characteristic of the islands. The second story of this portico, like most of the dwellings (fig. 6), is enclosed by shutters with immovable slats, which keep out heat and rain, but permit a free circula-

* The figures are arranged on plates at the end of this article.

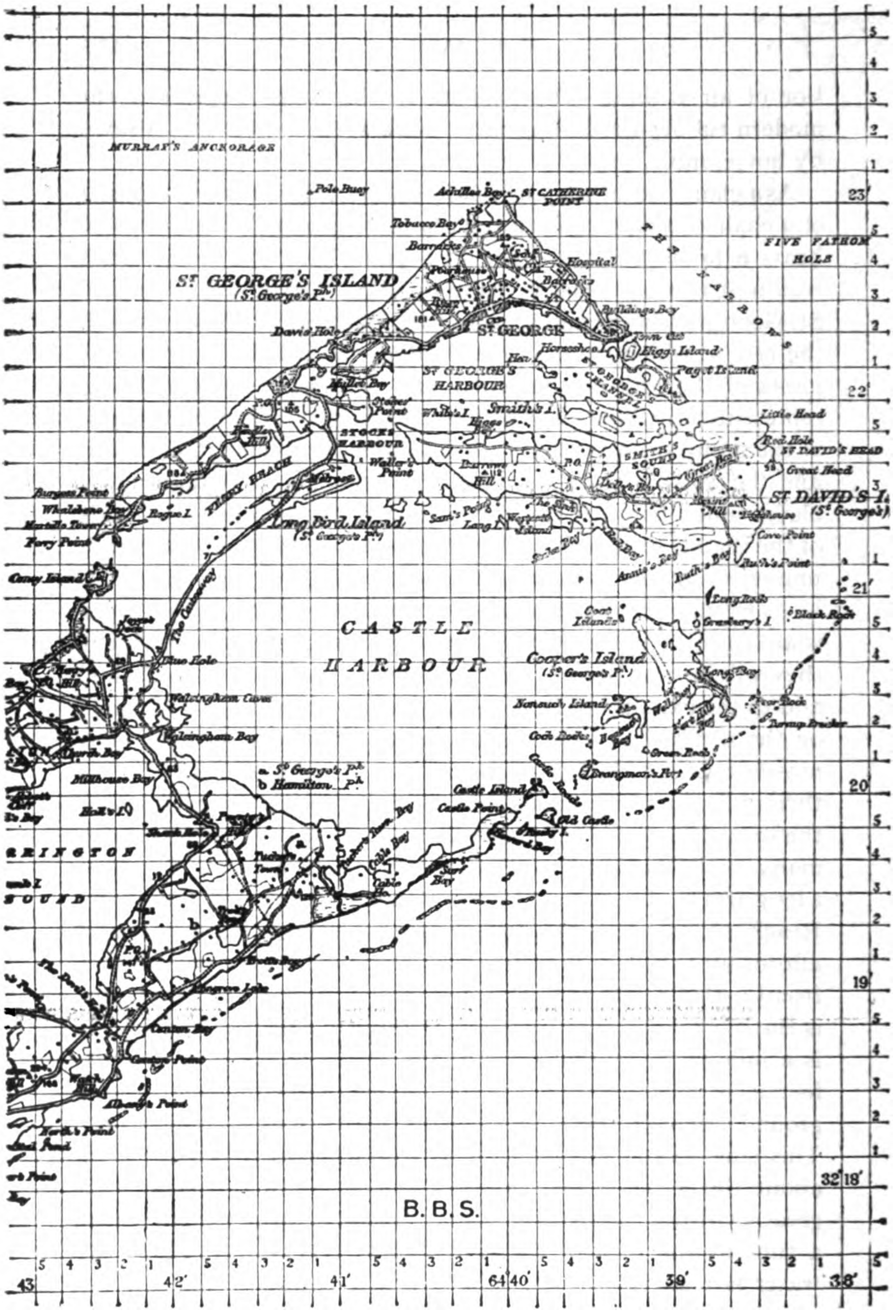
Map I.

Chart of the Bermuda Islands, with soundings in fathoms, the 100-fathom line (dotted), the ship channel (dashes), and the latitude and longitude to minutes.

tion of air within. The vehicles in the street range from the modern rubber-tired victoria to the low two-wheel cart drawn by horse, mule, or ox.

As a glance at the map will show (map 1), the Bermudas consist of a chain of about half a dozen islands so grouped that the whole bears a fancied resemblance to a gauntlet. The broad wrist region at the northeast is made up of St. David's, Smith's and St. George's islands and a part of the main, or Bermuda, island, the rest of which stands for the hand, the thumb and the first joints of the fingers, the remaining joints of the fingers being represented by Somerset and Ireland Islands. The whole length of the group from northeast to southwest is about fifteen miles, and the width is usually a mile or at most two miles; in many places much less. A fairly continuous ridge occupies the axis of the islands mentioned. Besides these larger islands, there are numerous smaller ones (fig. 15), so that it may well be that there is, as claimed, an island for every day in the year. The larger islands are so indented by bays and sounds that it is evident they will in time become divided up into smaller ones, and thus add to the existing number. The largest of the bodies of water on the north that seem to have eaten their way into the land masses is Castle Harbor (map 2). This lagoon is from two to three miles in diameter, and communicates with the open sea on the southeast by several passages separating from each other as many small islands, and with a great northern lagoon by means of a long arm of the sea called Ferry Reach. Connected with Ferry Reach at its northeasterly end is St. George's Harbor, which affords an excellent and well protected anchorage. Southwest from Castle Harbor, and separated from it by only a narrow ridge, is Harrington Sound, which looks like an inland lake (fig. 20); it is a mile wide, two miles long, and in places sixty or seventy feet deep. This has only one communication with the sea above ground, though there are several underground connections. This single surface-connection is by means of a passage only about thirty feet wide, through which the water rushes with great swiftness during every tide. It is surprising for how short a time at the turn of the tide, five or ten minutes only, the water is relatively quiet. This narrow passage leads directly

MAP 2.



Map of the Northeastern Third of the Bermuda Islands, with latitude and longitude lines ten seconds apart.

to the Flatts Inlet, which in turn connects with the great north lagoon. The Inlet, not being very broad, is therefore swept by a rather strong current. This region ("The Flatts," map 1) is of particular interest to us, for it is on this inlet that our laboratory is located.

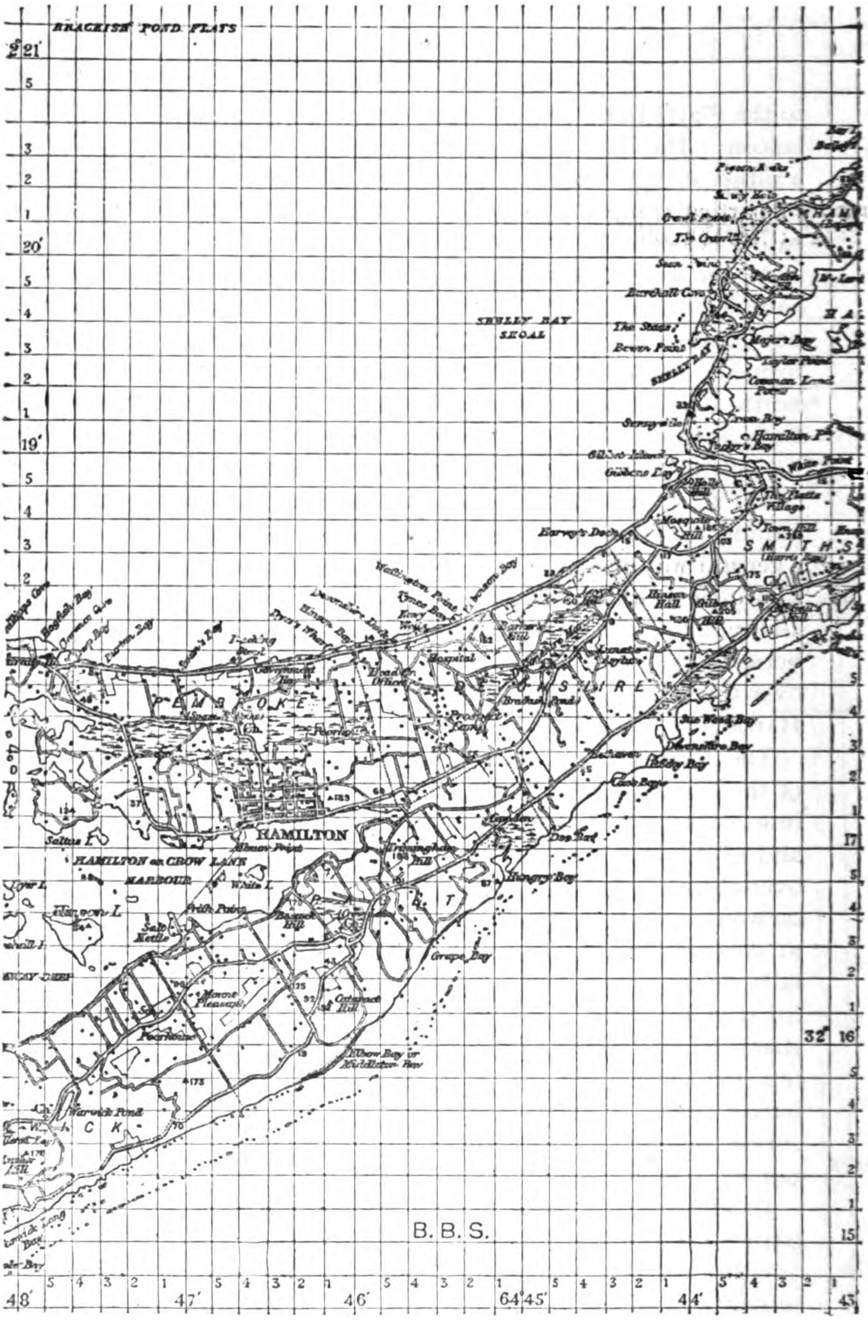
All the waters held, as it were, in the hand of the fancied gauntlet—Great Sound, Little Sound (map 4), Hamilton Harbor (map 3), etc.—form another extensive landlocked sea, which formerly, in all probability, communicated less freely with the north lagoon than at present, for a submarine ridge runs out from Spanish Point—the tip of the thumb—to Ireland Island. At several points this ridge is awash at low tide.

Through the greater part of the main island there are three parallel roads (map 3): one—known as the middle road—runs in a general way along the ridge; the others—known as north and south roads—run along the north and south shores. The north and middle roads meet at the Flatts, and nearly all the travel between the only two cities, Hamilton and St. George's, passes over the bridge which crosses the gorge between the Inlet and Harrington Sound.

The houses of Bermuda are, almost without exception, made of the limestone rock which everywhere abounds. This is cut into blocks a foot or more in length, eight or ten inches wide and of different thicknesses. Even the roof is made of thin overlapping slabs of the same rock supported by slats that rest on wooden rafters. The houses, roof and wall, are whitewashed at frequent intervals, usually twice a year. The rain that falls on the roofs is carefully collected in covered cisterns, for it is the only source of fresh water in the islands, since there are no streams, and most of the rain pools last but a few hours even after the heaviest showers. In some localities barren tracts of land are denuded, the rock cut to a sloping surface and whitewashed to serve as a watershed for collecting rainwater in larger quantity than the roofs supply.

In addition to the garrisons and the marines there are on the islands about 18,000 people, two-thirds of whom are negroes, one-third whites, mostly of English extraction. There is a property qualification for voting; the proportion of whites to

MAP 3



Map of the Middle Third of the Bermuda Islands. The position of the Laboratory is indicated by the lines "390" at the margins of the map.

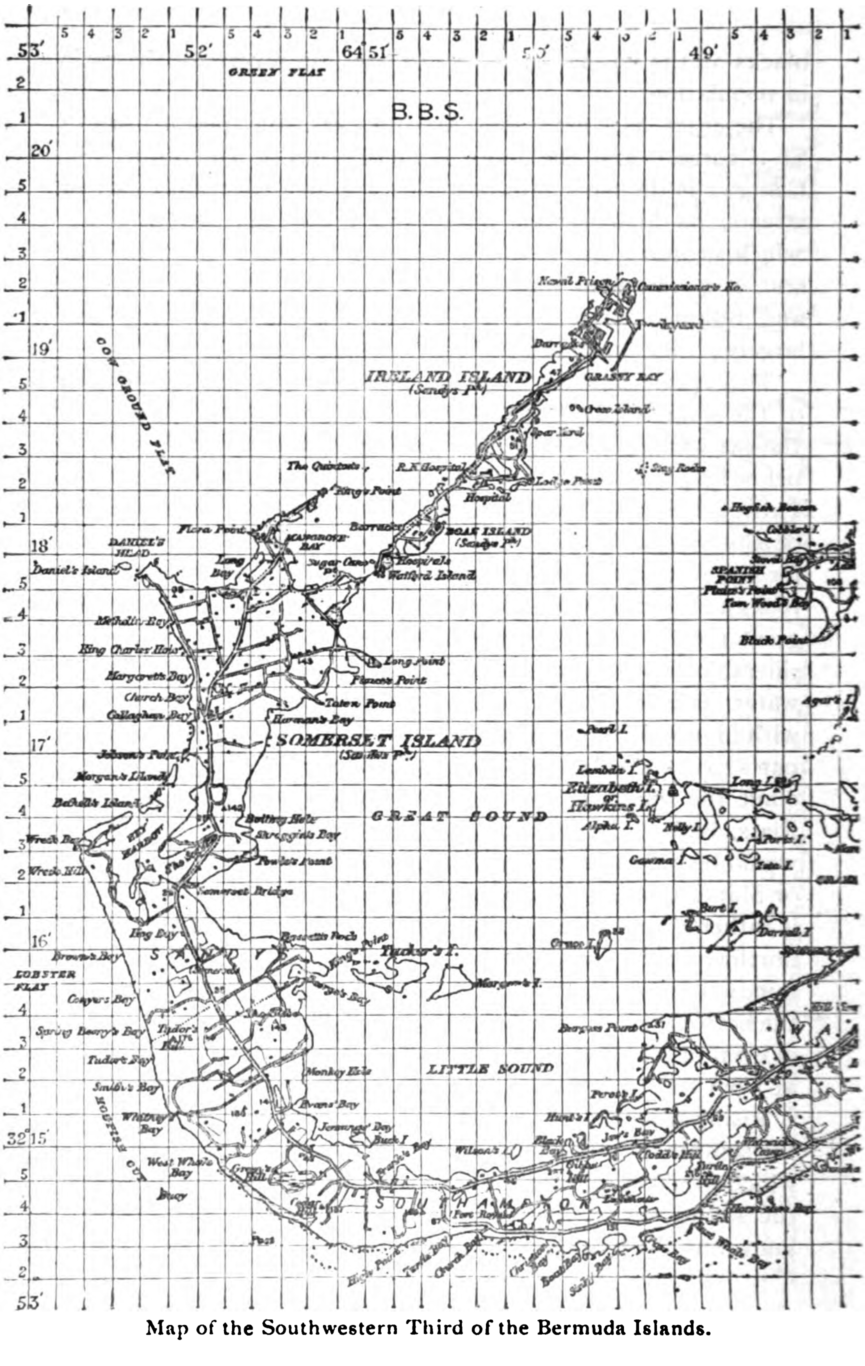
blacks on the voting list is two to one, the reverse of the ratio in population.

The cities, as I have said, are but two: the quaint town of St. George's, and the more modern town of Hamilton. St. George's is the more interesting because of its tortuous narrow streets, its high garden walls, and its ancient architecture, which suggest a mediæval European town (fig. 18). It was the seat of government until about a hundred years ago (1815), and retained for a long time after that an importance due largely to its fine harbor

The visible land of Bermuda gives a very incomplete idea of the shape of the submarine plateau from which it rises. If the sea were to recede so that its surface was about thirty feet below its present level, we should have a great oval lagoon some twenty-five miles long and from twelve to fifteen wide, the rim of which would be made up in part of the present land area, and for the rest of a more or less continuous reef of coral-covered rocks a mile or so wide (map 1). The great central basin—the great northern lagoon, as I have called it—would have no considerable depth—seldom more than fifteen or twenty feet of water, and nowhere more than thirty—and would be studded with innumerable coral rocks and islands. Some of the deeper parts have special names, as Murray Anchorage and Grassy Bay, while the shallower parts are known as flats—Brackish Pond Flats, Bailey's Bay Flats, etc. The passages through this rim would be only three: Hog-fish Cut, Chub Cut, and the Narrows or Ship Channel. The slope of the sea bottom outside the rim is rather abrupt on the southeast side of the oval, less so on the northwest side, and least of all at the ends, as the position of the hundred-fathom line shows. Beyond the hundred-fathom line the bottom slopes even more rapidly to a depth of 1,200, 1,500 or even in places to 2,000 fathoms. These depths are reached at from two to five miles beyond the hundred-fathom line.

Rising from the floor of the sea some ten or twelve miles to the southwest of this oval plateau is another much smaller one, which would still be some 150 or 200 feet under the surface were the sea to recede, as we have imagined, thirty feet. This is known as the Challenger Bank.

MAP 4



Map of the Southwestern Third of the Bermuda Islands.

Ten miles beyond this is another similar plateau of about the same size and height, called the Argus Bank. These two banks are in reality a part—two detached peaks, as it were—of the great submarine mountain of which the Bermuda Islands are the visible summit. For while the floor of the ocean sinks within five miles to about 1,500 fathoms, these plateaus are separated from each other and from the Bermuda plateau by less than half that depth.

The present land area of all the Bermuda Islands is composed of calcareous rock which varies from a loose sand to a firm, hard, semi-crystalline limestone that resounds to the blow of the hammer. What underlies this, no one yet knows. The deepest excavations—those for the new Navy Yard docks at Ireland Island—have not disclosed any other kind of rock. The numerous deep cuts for roads (fig. 19) and the quarries which are met with in all parts of the islands tell the same story. The rocks are composed of wind-blown calcareous sand. This sand, contrary to what was formerly supposed, is not composed of broken down corals. These are present only in small proportion, the chief constituents being fragments of shells, serpula tubes, and corallines. There are no such stratified subaqueous rocks as are found in this country, but everywhere the cut edges of the rock show the peculiar sinuous lines that characterize the stratification of drifting sands. The most, if not all, of the harder rocks are doubtless the result of the action of water and air on these æolian masses. At almost every point where the action of the sea is traceable it has resulted either in cementing together the layers of these æolian rocks till all evidence of stratification is lost, or else its mechanical effect has been more immediate than its chemical, and the rock has crumbled into its constituent grains and has become once more a sandy beach, in turn yielding up its substance to build the present sand dunes of the coast, which have the same æolian structure as their predecessors.

The mechanical action of the sea operating on the already hardened rocks has left them carved in the most fantastic shapes (figs. 2, 21) and with edges so sharp that it is almost impossible to walk upon them. In many places they are honey-combed

through the action of water, and subterranean passages connect inland waters with the sea. Caves, too, sometimes of considerable extent, are found at various places, especially in the northern part of the islands, about Castle Harbor and Harrington Sound. The floors of these caves are in some places below sea-level, and since there is a free communication with the sea, deep pools of sea-water are not uncommon in them. The water is so clear and unruffled that the incautious visitor is liable to walk into the pools unawares, even after being especially cautioned against it. The stalactite and stalagmite formations point to the solvent action of water as the cause of the caves. It is highly probable that many of the depressed areas of the land known as "sinks," as well as the sounds and harbors, are the result of the falling in of the roofs of caves. The "sinks" vary in area from a few square yards to many acres.

These depressions contain the peculiar reddish-brown earth that makes farming and gardening possible in the Bermudas. The richness of this soil and the favorable climate allow the farmer to keep the earth under constant cultivation and to procure several crops in the course of a year.

Although trees and shrubs in great variety are to be found in Bermuda, the most of them are not peculiar to the islands, but probably owe their origin to introduction by natural agencies from the West Indies and the United States before historic times, while many are known to have been introduced by man, and not a few of these within comparatively recent times. The Bermuda cedar (Juniperus bermudiana) may be indigenous, though fifty years ago it was also found in the Blue Mountains of Jamaica. The palms—a dozen species of which are said to be growing in the islands—and the palmettos, are the most noticeable growths to attract the eye of the northerner. The royal palm (fig. 17) surpasses all others both in height and in beauty, but the cocoanut palm (fig. 12) is a worthy second, and many specimens of it are striking features of the landscape. In Queen Street, Hamilton, one drives beneath the sprawling branches of what we call a "rubber plant" when it grows in pots in our conservatories. Here its branches have a spread of a hundred feet or so. On

entering the Public Garden at St. George's, where many interesting exotics are found, one is confronted by a stately screw pine of most symmetrical form, twenty or thirty feet high, and in the Agricultural Gardens near Hamilton another Pandanus of less graceful form but greater breadth is seen. Our common deciduous trees, however—the maples, beeches, birches, and oaks—are entirely wanting. In a private garden that contained many interesting trees and shrubs from various parts of the world I was shown as one of the greatest of curiosities a sickly specimen of one of our oaks. Even with the utmost care and attention these trees cannot be made to flourish in Bermuda; but oleanders have been introduced and flourish almost beyond belief. They are often used as hedge rows and grow to a height of 20 or 25 feet. A great variety of tints from deep scarlet—almost crimson—to pure white are to be seen. From May to September they enliven the face of the land with their brilliant colors, which occur in such masses that they are the admiration of all who see them. On the bleak north shores the tamarisk has been planted as a break against wind and salt-water. Though not an especially graceful shrub, the soft green of its fine-cut foliage makes a pleasant impression on the eye, and it enjoys the great practical advantage of being about the only kind of verdure that can really thrive in the presence of the abundant salt spray which the prevailing winds drive in upon the land.

The fiddle-wood tree (Citharexylum quadrangulare) is today the commonest of the deciduous trees in Bermuda, but the first tree of this species on the islands—the one from which all the others are said to have come—was imported as recently as 1830, and is still standing. The pride of India (Melia azedarach) is a rather scraggy, forlorn looking tree in midsummer, and one wonders why it is so much cultivated; but in early spring, before the leaves are out, it puts forth a profusion of pink flowers that makes it a great favorite with the Bermudians. It seems as though Bermuda must be the home of the genus Hibiscus, so many species are met with. In midsummer their blossoms exhibit some remarkably gorgeous colors. Still, the most superb of all the ornamental

trees and shrubs to be seen in Bermuda is the Poinciana regia, a native of Madagascar, a tree with spreading branches clothed in the most pleasing green and decked with beautiful clusters of brilliant red blossoms.

The land animals of Bermuda, with the exception of insects and mollusks, are remarkably few, and of these the most are probably not natives of the islands any more than are the majority of the phænogamic plants.

Except for domesticated animals, mammals are numerous neither in species nor individuals. The most interesting one is doubtless the Wood Rat (Mus tectorum), which lives in trees and is now nearly extinct. This was at one time a dreaded scourge to the early settlers. Nearly 300 years ago (1619) Governor Butler, writing of the timely arrival of a so-called runaway frigate that brought food and thus averted impending famine, said: "But howsoever this runne away frigate brought with her a timely and acceptable sacrifice of her meale; yet the companions of her meale, numbers of ratts (which wer the first that the ilands ever sawe), being received with-all and on a soudaine multiplyinge themselves by an infinite increase (for ther is noe place in the world so proper for them), within the space of one only yeare they became so terrible to the poore inhabitants, as that (like one of Pharaoths plagues) the whole plantation was almost utterly subverted therby; and so farr gone it was at last, that it proved Captaine Tucker's masterpiece all his time (which was not long after) to devise trapps and stratagems to conquer and destroye them, though indeed all of them proved to noe purpose (as you shall see hereafter) untill afterwards, one moneth of cold and wett weather did the deed." It is by no means certain, however, that these rats had not long existed on the islands, even though an earlier writer, Silvanus Jourdan, says (1610): "The countrey (foreasmuch as I could finde myself, or heare by others) affords no venimous creature or so much as a Rat or a mouse, or any other thing unwholesome."

Whales, which were once of some commercial importance to Bermuda, are so rare that they are no longer hunted, and the "whale-houses," of which there were recently half a dozen in

existence, are but relics of an industry that has practically ceased.

The greater part of the 150 or more birds mentioned by Major Wedderburn (Jones: "The Naturalist in Bermuda"?), as found in the Bermudas, are migrants. The most conspicuous and interesting of them is the Tropic or Boatswain bird (fig. 16), which still continues to nest here, usually on the more remote and inaccessible islands.

The only representative of the Amphibia is the great Surinam toad (Bufo agua), which was introduced into Bermuda some twenty-five or thirty years ago by Captain Nathaniel Vesey to combat insect pests. I was fortunate enough during my first visit to Bermuda to find several of these toads spawning on the morning of April 22. There had been a heavy shower during the preceding night, which had resulted in temporary pools of fresh water in a few places, and it was in one of these pools near Spittal Pond that a half dozen or more pairs were found. A quantity of the spawn was secured and a series of eggs preserved.

Reptiles have at present very few representatives. There are no snakes, and the possible importation of them is carefully guarded against. The only land reptile is the Bermuda lizard (Eumices longirostris), which is not found elsewhere and is probably indigenous. Of turtles four species, none of which are peculiar to Bermuda, are known to frequent the islands— the green turtle (Chelonia mydas), the hawkbill (Eretmochelys imbricata), the loggerhead (Thalassochelys caouana) and the trunk or leather turtle (Sphargis coriacea). The green turtle is still caught in nets in small numbers, but the others are found only occasionally. From the accounts of several of the early writers on Bermuda it is evident that some of the turtles (perhaps the green turtle) were once very abundant. Sylvanus Jourdan, writing of the shipwreck of Sir George Somers in 1609, says: "There are also great store of Tortoises (which some call turtles), and those so great, that I have seene a bushell of egges in one of their bellies, which are sweeter than any Henne egge: and the Tortoise itselfe is all very good meate, and yieldeth great store of oyle, which is as sweete as any butter: and

one of them will suffice fifty men a meale at least: and of these hath beene taken great store, with two boates at the least forty in one day. . . . We carried with vs also a good portion of Tortoise oyle, which either for frying or baking did vs very great pleasure, it being very sweete nourishing and wholesome." An early account of their egg-laying, by Peter Martyr, is given in these words: "At such time as the heate of Nature moueth them to generation, they come forthe of the Sea, and making a deepe pit in the sand, they lay three or foure hundred Egges therein: when they haue thus emptied their bag of Conception, they put as much of the same againe into the Pit as may satisfie to couer their Egges, and so resorte againe vnto the Sea, nothing carefull of their succession. At the day appointed of Nature to the procreation of these creatures there creepeth out a multitude of Tortoyses, as it were Pismyers out of an anthill, and this only by the heate of the Sunne, without any helpe of their Parents: their Egges are as big as Geese Egges, and themselues growne to perfection, bigger than great round Targets."

It is, however, the richness of the life in the sea, in marked contrast to the paucity of that on land, which is the chief source of attraction to the zoölogist. If the gardens on the land require much attention and are the reflection of man's assiduity in transplanting the products of one country to the soil of another, the gardens of the sea demand no such care, and man has had little or nothing to do with shaping the wonderful display of marine life that carpets the floors of the broad lagoons and the reefs of the Bermuda plateau.

Before speaking about the life in the seas, however, I wish to say a few words about the Bermuda Marine Laboratory. Not very long after my conversations with President Eliot, and when I was considering ways and means of providing an opportunity for students to work at Bermuda, I had the good fortune to make the acquaintance of Professor Bristol, and hear from him for the first time a glowing account of his experiences of several years, and his plans and hopes regarding a somewhat similar undertaking. Our aims had so much in common that co-operation seemed desirable to both of us, and we at length agreed to un-

dertake, with the aid of the Bermuda Natural History Society, to equip and manage a provisional laboratory, which might serve till such time as the Colonial Government should be able to put at the disposal of biologists a permanent station. Chiefly through the enthusiastic interest of Dr. Bristol, in co-operation with the Bermuda Natural History Society, the Colonial Government had been led to entertain the idea of establishing a public aquarium for the enlightenment and amusement of people resident in the islands as well as the tourists, and in connection with it a marine laboratory for biological investigations. A Joint Committee of the Legislative Council and the House of Assembly, consisting of Sir S. Brownlow Gray, Chief Justice, Hon. Eyre Hutson, Colonial Secretary, and assemblymen J. H. Trimingham, Nathaniel Vesey, and A. Gosling, was appointed to consider the advisability of establishing such a station, and in due time reported favorably on the undertaking. The Governor, Lieut.-General Geary, at the suggestion of the Committee, entered into correspondence with many institutions and individuals both in Europe and America with a view to ascertaining their opinions as to the desirability of establishing such a station and the possibility of their co-operation. The replies were all favorable, and a certain amount of support was promised. Early in 1903 Professor Bristol and I were invited by the Natural History Society to visit Bermuda for the purpose of looking into the conditions and giving advice with regard to the general plan and certain matters of detail. This we did towards the end of April. Upon our return, and after the money necessary for the undertaking had been secured, we issued to biologists in the name of the Bermuda Natural History Society and the Universities which we represented an invitation to share for six weeks in the privileges of a temporary biological station at the Flatts, Bermuda. The generosity of the Natural History Society and the liberality of our friends allowed us to provide ample means for collecting and all the requisites for laboratory work, except that we had no running water in the laboratory. The building, however, was only a short distance from the sea, so that this deficiency was not very serious.

Through the favorable terms for transportation secured from

the Quebec Steamship Co., and for board and lodging at the Hotel "Frascati," it was possible to make the cost of staying six weeks at the station, together with transportation from New York and back, only one hundred dollars. Thirty-seven persons availed themselves of this opportunity, and of these thirty-three were engaged in the study of zoölogy or botany, four being companions of one or another of those who were working in the laboratory. Of these thirty-seven persons about a dozen sailed from New York on June 20, the remainder two weeks later. Arriving in Hamilton, the party was met on board the steamer and welcomed by Archdeacon Tucker, President of the Bermuda Natural History Society, U. S. Consul W. Maxwell Greene, Vice-President, F. Goodwin Gosling, Honorary Secretary, and other members of the Society. A carriage ride of four miles over Mt. Langton and along the north road—from which one gets magnificent views of the great north lagoon and its ever-changing appearance—brought the party to the Flatts and the hotel. The Flatts village (fig. 4) centers at the cross-roads near the bridge (figs. 30, 31) which spans the narrow passage from the Inlet into Harrington Sound. It contains the hotel, the post-office, a half-dozen shops, and one or two scores of dwellings, which range in size and attractiveness from "Palmetto Grove," the home of Archdeacon Tucker, to the twenty-foot cottage of the unambitious colored family. On nearing the Flatts the north road runs along the hillside that rises to the south of the Inlet, gradually descending to sea level at the corners, where it meets the middle road. The cottages are scattered over this hillside, which looks out on Harrington Sound (fig. 30) and affords at many spots beautiful views of that land-locked sea and the wooded heights beyond. The hotel (figs. 13, 31) is located on a low projection of land that makes out into the Inlet from its south shore and commands on one side a view of the sea (fig. 9) on the other a view into Harrington Sound. It consists of half a dozen buildings; two of stone (one built as a residence many years ago) placed gable to gable and facing the water; a much newer wooden structure, which, with its broad piazza, projects out over the clear waters of the Inlet; the kitchens and a storehouse behind the older buildings, and, lastly, a new stone build-

ing some forty feet square, located back of the wooden one, between it and the public road. This building we rented for a laboratory (fig. 8). It had been divided up by light partitions into several rooms, and proved to be fairly well adapted to our needs. The laboratories were furnished with substantial work tables having ebonized tops and banks of drawers. A library of specially selected books and pamphlets from the libraries of the Museum of Comparative Zoölogy, the Boston Society of Natural History, and the writer, several hundred in number, were arranged in the largest work room. An ample supply of glassware, reagents and preservatives, dissecting lenses, microtomes, paraffin imbedding devices, and all the other usual equipment of a zoölogical laboratory were provided, as well as the necessary appliances for collecting, such as dredges, nets, seines, tubs, buckets, sieves, water glasses, *et cetera*, so that few wants were felt in this direction by any of the party. The number of students was, however, so large that the laboratory building was inadequate for the accommodation of all. When the second party arrived, therefore, a large ground-floor room in one of the stone buildings of the hotel was fitted up with portable tables for those who had less need of appliances for microscopic work.

Very satisfactory means of transportation to collecting grounds, both by land and by water, were provided. For places not readily accessible by boats, wagonettes and carriages were furnished, and those who collected land plants made much use of them. Several persons had brought with them their bicycles, and thus were less dependent on the organized parties. Regular excursions were arranged for nearly every day except Sundays; frequently two in a day, and sometimes two by sea and one by land. As far as practicable, shore collecting and coral "nipping" on the reefs were planned for the low-tide hours of the day and dredging for other times.

One of the places most frequently visited by land conveyance was Hungry Bay, on the south shore nearly opposite Hamilton. The entrance to the bay is narrow and rocky, yet a great variety of animals are blown in by the southerly winds and the place has thus become a rich collecting ground. The loose and porous rocks just inside the entrance on either shore afford

hiding places for great numbers of worms and other invertebrates. Upon turning over these rocks the bottom seems alive with creatures of many kinds. Only half the booty is seen, however, unless the rocks are broken into fragments. Thus are set free boring mollusks, annelids, and many other forms that find protection, or a lair, in the holes and tortuous passages of this porous, honey-combed limestone.

In many places the floor of the shallower parts of the bay is covered by a large tubularian hydroid, in others, where the current is stronger, by great yellowish or greenish patches of colonial actinians (Palythoa) belonging to the Zoanthidæ (fig. 27). The upper end of this bay is a swamp of mangroves (compare fig. 14), on the branches of which numbers of tree crabs (Goniopsis cruentatus) clamber about. To catch these creatures requires some skill, two persons usually succeeding better than one, for the crab when too closely pursued quickly drops to the ground, even from a height of 10 or 15 feet, and escapes into a burrow, unless a net is dexterously interposed during its descent. Along the edges of the tidal stream near the head of the bay are found in great numbers prawns that are so transparent as to escape observation until they move. They dart about with such swiftness that it is difficult to take them in the net.

When one cautiously approaches the edge of the cliffs that flank the entrance to the bay and looks down on the hard, wave-beaten rocks, he sees large numbers of crabs that take alarm at the least motion and scurry away to crevices, or scramble down into fairly deep water, where, with their sharp claws, they are able to cling to the rough rocks and make almost as good progress as in the air. On the platforms and in the niches of the rock between tide marks are congregated hundreds of chitons (Chiton marmoreus), whose shells give proof of the action of the waves, which are almost constantly dashing against them at high water.

In view of the possibility of the establishment of a permanent station, it seemed desirable to keep records of the places where various animals and plants were found. To this end each person was provided with a note-book, and to prevent duplication of locality numbers, certain locality numbers were assigned with

each book. Whenever a party of individuals made collections together in a circumscribed area, as in dredging, or in shore collecting at particular spots, the same locality number was used by all. To enable future workers to find the precise localities mentioned, these places were designated by latitude and longitude. Fortunately for this plan there had been recently published an Ordinance-Survey map of the Bermudas on a scale of 880 feet to the inch, so that by ruling one of these maps with rectangles ten seconds square it was possible to indicate on the map the position of any locality to within a very few feet, as the position of the laboratory is shown on Map 3.

A card catalogue embracing the names of all the animals and plants arranged systematically will ultimately show, not only what organisms, both living and fossil, are to be met with in the islands and adjacent waters, but also the precise localities at which they have been found, and the conditions under which they live. To this will be added as rapidly as possible the periods of ovulation, etc., so that one may not waste time in searching in the wrong place or at the wrong time of year for the material one needs.

In the immediate vicinity of the laboratory—in the Inlet and in Harrington Sound—are found an abundant supply of many interesting animals. From the stone pier at the hotel are to be seen great numbers of brightly colored fishes—the yellow-banded Sergeant Majors (Abudefduf saxatilis), Sea Squirrels (Holocentrus ascensionis), so called on account of the bigness of their eyes, Angel fishes (Angelichthys ciliaris), Four Eyes (Chætodon bimaculatus), and many others. The large eye-spots of the Four Eyes at the tail end of the body evidently afford protection by misleading their enemies into the belief that they will attempt to escape in a direction opposite that in which they actually swim. Schools of blue fry and other small fishes pursued by their enemies make a flash in the sunlight as they leap from the water and a sound like the patter of rain as they descend. Small shoals of White Grunt (Bathystoma), that so closely resemble the sandy bottom as to be almost invisible, are slowly patrolling along the beach and often attract one's attention only when their presence causes a commotion among their prospective victims.

The water is so clear that the bottom at a depth of fifteen or twenty feet is seen as distinctly as it would be beneath as many inches of our northern waters. Along the sandy stretches of the Inlet, where the current is not too strong, are numerous dark sea-urchins (Toxopneustes variegatus), which have the interesting habit of covering themselves with empty shells, sea weeds, or any loose available fragments. Just what sort of protection these screens afford, is not quite apparent. To the observer looking from above they are scarcely less conspicuous than when unadorned. Their specific form and characteristic color, it is true, are masked, and possibly this is enough to subserve some useful purpose. By digging a few inches deep in the sand at the right spot one brings up another echinoid, the sand-dollar (Mellita sexforis). Scattered over the bottom are the appaparently motionless but conspicuous sea-cucumbers, which the natives call sea-puddings—the Stichopus diaboli, and S. xanthomela of Heilprin. These often attain the length of a foot or more and leave behind, to mark the track of their slow progress, a cord or ridge of sand that has been deprived of its nutritive material in passing through their intestinal tract. These are abundant on many sandy bottoms ; other holothurians are less widely distributed. In the shallower parts of the Inlet, which are laid bare at low tide, are the burrows of many annelids and other worms. Where the channel is rocky and the water moves with greater velocity the bottom is often gorgeously painted with patches of bright-colored corallines and encrusting sponges. Opposite the hotel an artificial channel, cut through the narrow neck of land that separates the Inlet from Harrington Sound, is of this nature and affords a rich collecting ground for many invertebrates. With a row boat and a good water-glass one may study with delight the shores of Harrington Sound and its numerous coves and get beautiful views of the delicate shade-corals (Agaricia fragilis, fig. 28), the many kinds of sea anemones (figs. 24–26), and the sponges which abound there. Collecting is easy, and the variety of life great. Occasionally the long "whips" of the Bermuda lobster (Panuliris argus) are seen projecting out of some crevice in the rock, as he lies in wait for his prey. If less palatable than our American

lobster, the Bermudian has a more graceful form and a much handsomer livery (fig. 22).

In addition to a thirty-foot sail boat, with its glass-bottomed fish-well, such as the native fishermen use, the Station was furnished in the summer of 1903 with a steam launch (fig. 7) some 35 feet long—the "Minnow." For three-fourths of her length she had a light wooden deck and side curtains, which could be lowered to keep out sun, rain, or spray. Her pilot house was low, but roomy, and served as a forward cabin as well as wheel house. In this launch almost daily excursions were made to various parts of the archipelago, according as the conditions of wind and tide favored this or that locality. For all purposes except that of dredging she was well suited to our needs, for, being of light draught, she could be used about the shoals and flats with safety and ease.

I recall with pleasure not only my own fascination, but also the expressions of delight which involuntarily came from the lips of all who, with water-glass in hand, peered down into the fairy-like gardens of the sea, as we slowly drifted with the tide, or lay at anchor in the midst of one of the great coral patches that flourish over extensive areas of the north lagoon. I confess the pleasure was so great that the spirit of the collector was suppressed for the time being; it seemed sacrilege to touch with violent hands a picture that showed such harmony of form and color,—the waving plumes, the graceful branches of the gorgonias; sea fans in purple splendor; coral heads of gold and green; great splotches of colored sponges encrusting the rocks; the soft sea weeds; here and there deep channels with nothing but the clear water and the white sand beneath it; and in and out among this maze of growing things, the graceful, noiseless fishes in such array of colors as is scarcely credible, much less describable. I believe it may be truly said that one who has never seen such a tropical sea-garden cannot have the remotest idea of its charms. There was only one consideration that could reconcile me to the wanton work of collecting these beautiful things and robbing them of all their native charm; that was the fact that, work as diligently as we might, we could not deface one in a thousand of these fascinating spots. I think there is no other single experience I would

willingly exchange for this, and yet I recall one other, of a somewhat different nature, that made a strong impression on me. As three of us were out one afternoon off the south shore beyond the reefs fishing in about sixty fathoms, there came floating past with the tide a school of jelly fishes, the common Aurelia. I have before seen Aurelia almost cover the surface of the sea, but never before had I been able to look down, as then, and see them in the depths of the sea. They were seemingly without end, a vast procession, smaller and smaller the deeper one gazed, until they seemed mere specks, such was the clearness of the water.

For use in dredging a larger steamer (fig. 11), the "Intrepid," was for a part of the time at our command in place of the "Minnow." This steamer was provided with a boom in front of the pilot house, which much facilitated dredging operations, and the forward deck was a convenient place for inspecting the dredgings, assorting tows, etc. This was the steamer that had been employed by Mr. Agassiz during his explorations in 1894. With her we made, besides other excursions, several trips to North Rocks (fig. 5)—three sole survivors of the land mass that doubtless extended in previous times along the northern border of the lagoon, as the present land area now does along its southern rim. It is only on the calmest days and at lowest tide that one may safely land on the plateau from which these three pinnacles, called North Rocks, arise. The steamer can approach within a half or a quarter of a mile and then must anchor, while in rowboats the collectors make their way to this sea-washed platform. On the sea face the rock, which is an æolian limestone, is slightly raised above the general level of the floor, and is overgrown with nullipores and other corallines, as well as non-calcareous algæ; and here serpulas, millepores, and porites abound. Even at low tide this rocky platform is barely above water, and it is so honeycomed and porous that its surface is very irregular. The flatter portions are covered here and there with patches of the curious Zoanthidæ. There are innumerable pools and channels, all showing the greatest variety of color in the plant and animal life that clothe their sides and bottoms. Here, in the pools and passages, is a greater wealth and variety of life than can be found in an equal area elsewhere in all the Bermuda archi-

pelago. Located on the very edge of the outer reef, where breakers are always running, save in perfectly calm weather, the conditions seem to be especially favorable for many of the marine organisms. Numerous small and brilliantly colored fishes dart about in the pools, and escape into the crevices of the rock as one attempts to scoop them up. The great black sea-urchin (Diadema setosum), bristling with slender spines, is firmly ensconced in niches in the rocky floor, and usually defies all attempts at removal. But by breaking away the rim of projecting rock this urchin may sometimes be dislodged. Unless great care is used, however, his spines, which are like needles, will penetrate the flesh, where they are sure to break off and become a source of great irritation if not promptly removed ; but they are so brittle that removal is not an easy matter. Crabs, both great and small, are everywhere, and the little hermits, with their molluscan shelters of various kinds and sizes, make a grotesque appearance as they scuttle away to cover.

One of the most novel sights that I saw in these tropical seas was viewed through a water-glass near North Rocks. A school of small fishes (Atherina) swimming in a nearly spherical mass ten or fifteen feet in diameter, seemed to be slowly revolving through the water as its individuals swam round and round in an almost solid mass. It was not at first apparent how the mass preserved such a constant form, but at length it was seen that a few individuals of another and larger species of fish were acting the part of the shepherd dog, and that the smaller fishes were actually being herded—a flock of submarine sheep. Nor do the herding fishes prey upon their flocks. The explanation is interesting. Three kinds of fishes are involved in this association. The herders accompany and "round up" the smaller fishes, so that other kinds of fish which are wont to prey upon them may, as they approach with murderous intent, fall victims to the herders.

Picturesque Castle Island, which still contains ruins of early fortifications, some of them possibly dating from the early part of the 17th century, once guarded the entrance from the sea through the channel of Castle Roads. From the floor of this channel the dredge brings up many interesting animals: the

great conchs (Strombus gigas), the shells of which are still prized by tourists, living Foraminifera of several kinds, and best of all, the Carribean Amphioxus. This species was dredged in considerable numbers at various places during the summer of 1903, and especial attention was given during the past summer to finding out how widely it is distributed, and the conditions under which it thrives. As a result, we now know that there are ten or a dozen localities where it is found in large numbers, and that a fairly coarse, clean sand, and strong currents of clear water are conditions that it generally seeks. The peculiar odor, resembling that of iodine, which is a noticeable feature of the "Amphioxus sand" in the bay of Naples, was not recognized at any of the collecting places examined by us. Incidentally in our dredgings for Amphioxus, it was noticed that there are many sandy bottoms and beaches which are inhabited by large numbers of a rather small Balanoglossus. The western portion of Castle Harbor contains brain corals (Meandra) in great abundance, many of them attaining an enormous size and weight. The rocky shores, overgrown with encrusting sea-weeds, are a favorite browsing place for the great opisthobranch mollusks (Aplysia), which the Bermudians call sea-cats (fig. 23).

Off the south shore, at a distance varying from a few rods to a quarter of a mile, runs a rocky ledge,—a kind of barrier reef,— over which the sea is breaking incessantly. Here and there the rocks take on the form of a huge bowl or crater (fig. 10), from the rim of which the water pours over after each swell of the sea in a beautiful cascade. These diminutive atolls are known locally as "the boilers."

During almost every excursion through the northern lagoon there were encountered extensive patches of floating gulf weed (Sargassum), which, I may mention, grows at certain points along the south shore. An examination of the larger masses almost always yielded an abundance of various crabs, bryozoans, and nudibranchs, some of the latter being most beautifully colored. Frequently the less common fishes, such as the pipe fish (Syngnathus) and the grotesque Antennarius, were found in these floating islands, evidently their natural home. After protracted strong winds there are thrown upon the beach long windrows of

this gulf weed, which harbor a variety of the animals that live on the open sea. At such times the Portuguese man-of-war (Physalia) is frequently so abundant as to make the beach purple with its floats.

Through the generosity of Captain William E. Meyer, of St. George's, a three-days' trip to the Challenger Bank was arranged for all the members of the station who desired to go. Captain Meyer put at our disposal his sea-going steam tug, the "Gladisfen," and her crew. Many hauls of the dredge were made and rare corals, crustacea, and other invertebrates secured. The edge of the bank is an ideal fisherman's ground, abounding in Red Snappers (Neomæius aya) and Amber-fish (Seriola dumereilii). As might be expected, sharks, too, are found there in abundance.

Some of the investigations undertaken by us have already been published as Contributions from the Station; others are in press or in course of preparation. Mr. Leon J. Cole's paper on the Pycnogonida (Proc. Bost. Soc. Nat. Hist., Vol. 31) contains an illustrated description and critical discussion of three species, one of which is new. Mr. Addison Gulick has described (Proc. Acad. Nat. Sci. Phila., Vol. 56) some twenty-five species of fossil shells, seven of which are new, from a number of localities, and has pointed out their relationships to shells of Eastern North America and the West Indies. Notes on birds seen during July and August have been published by Mr. Harold Bowditch (Amer. Nat., Vol. 38). Professor Coe, of Yale University, has published an important paper on one of the very interesting land nemerteans: "The Anatomy and Development of the Terrestrial Nemertean (Geonemertes agricola) of Bermuda" (Proc. Bost. Soc. Nat. Hist., Vol. 31).

Among the other subjects for which material was collected, or upon which investigations were carried on are the following: The internal parasites of fishes, fossil vertebrates, new marine fishes, shoal-water deposits, land mollusks, insects, myriapods, annelids, land planarians, bryozoans, acalephs and hydroids, foraminifera, diatomaceous earth, marine plants, and the conditions of swamp formation.

During the past summer we had the use of the steam launch

"Flora," owned by Mr. Henry H. Barton, of this city. This launch was larger (about 45 feet over all) and in many ways better than the "Minnow." This year we were fortunate enough to find at several localities a near relative of Amphioxus, the interesting Asymmetron, which was discovered several years ago at the Bahamas by Prof. Andrews, of Johns Hopkins University. This was first recognized at Bermuda by Mr. Louis Mowbray, of St. George's, who was a member of the Station party. It is an interesting fact that, so far as our search extended, Amphioxus and Asymmetron do not inhabit the same sand banks. The Bermuda Asymmetron is much smaller than Amphioxus and much more expeditious in burrowing into the sand. Amphioxus is remarkably quick in its movements, but Asymmetron is quicker. The habits of these two primitive vertebrates, as well as the finer anatomy of their nervous systems, and the anatomy and physiology of other organs, were studied by members of the party this year, and will form the basis of special papers to be published later.

In conclusion, I wish to state that the Bermuda Government has decided to erect a permanent Aquarium and Biological Station at the Flatts, in accordance with the plans that I have already referred to, and has voted a sum of money (about \$20,000) for the undertaking, and a smaller annual sum (\$2,000) for its maintenance. It is expected that when the buildings are completed arrangements will be made to have the Station open for research throughout the year.

Explanation of Figures.

I am greatly indebted to Professor A. E. Verrill for the use of the cuts shown in Figures 14 to 29 inclusive, which are taken from the Transactions of the Connecticut Academy of Science and from his "The Burmuda Islands," New Haven, 1902, and "Zoölogy of the Bermudas," New Haven, 1903; also to Mr. A. Peniston for the use of Figures 30 and 31.

Plate 1.

Fig. 1.—View of Hamilton from the Harbor. From a photograph by Phelps Gage.

2.—Water-worn rocks, south shore.

Plate 2.

3.—Front Street, Hamilton; U. S. Consulate in the distance. Photo. by L. J. Cole.

4.—View of Flatts Village from window of Hotel Frascati. Photo. by A. M. Miller.

Plate 3.

5.—North Rocks. From photograph by Phelps Gage.

6.—Residence surrounded by palmetto trees. Photo. by Phelps Gage.

Plate 4.

7.—The "Minnow" starting on an excursion. Photo. by Albert Mann.

8.—The Laboratory, western face. Photo. by C. L. Bristol.

Plate 5.

9.—View of "Wistowe" and the Inlet from the piazza of Hotel Frascati, looking toward the great north lagoon.

10.—Diminutive atolls ("boilers") in the foreground; reef in the distance.

PLATE 6.

FIG. 11.—The "Intrepid." From a photograph by L. J. Cole.
12.—"Wistowe," residence of the widow of the late U. S. Consul, Hon. C. M. Allen.

PLATE 7.

13.—View of Hotel Frascati, looking out through the Inlet. Photo. by Albert Mann.
14.—Walsingham Bay. Mangroves and, in the background, cedars. Photo. by W. G. Van Name.

PLATE 8.

15.—Great Sound, looking south from Spanish Point.
16.—Tropic Bird. Photo. by A. H. Verrill.

PLATE 9.

17.—Royal palms at Pembroke Hall, near Hamilton.
18.—Ancient street in St. George's. Photo. by A. H. Verrill.

PLATE 10.

19.—Road cutting near Hamilton.
20.—Harrington Sound. Photo. by A. H. Verrill.

PLATE 11.

21.—Cathedral Rocks, looking north. Photo. by A. H. Verrill.

PLATE 12.

22.—Bermuda Lobster. About ¼ nat. size. Photo. by A. H. Verrill.

PLATE 13.

23.—Sea-cat (Tethys [Aplysia] dactylomela). × ⅓. Photo. by A. H. Verrill.
24.—Actinian (Lebrunia Danæ). × ½. Photo. by A. H. Verrill.

PLATE 14.

FIG. 25.—Anemonia elegans Verrill. $\times 1\frac{1}{2}$. Photo. by A. H. Verrill.

26.—Phellia rupa Verrill. From life. $\times \frac{1}{2}$. Photo. by A. H. Verrill.

27.—Palythoa grandiflora. A group of living animals. Nat. size. Photo. by A. H. Verrill.

PLATE 15.

28.—Skeletons of Shade Corals. $\times \frac{3}{5}$. Photo. by A. H. Verrill.

29.—Mussa (Isophyllia) fragilis, young. Nat. size. Photo. by A. H. Verrill.

PLATE 16.

30.—View of the bridge and Harrington Sound from the heights above the hotel.

31.—View of the bridge from Harrington Sound side. Inflowing tide. Hotel Frascati seen over the bridge.

PAPERS READ.

Natural and Artificial Parthenogenesis. By Alex. Petrunkevitch.

Heredity of Coat Characters in Guinea Pigs and Rabbits. By W. E. Castle.

Tropical American Fresh-Water Fishes. By C. H. Eigenmann.

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ADDRESS

BY

THOMAS H. MACBRIDE,

VICE-PRESIDENT AND CHAIRMAN OF SECTION G FOR 1904.

THE ALAMOGORDO DESERT.

The Alamogordo desert of southern New Mexico lies immediately west of the 106th meridian, west, and approximately between thirty-two and thirty-four, north. It is bounded on the north by the Oscuro range of mountains, on the east by the Sacramentos, on the south by the Jarillas and the Organ mountains, on the west by the San Andreas. As here defined, therefore, the desert is of comparatively limited area, one hundred or one hundred and twenty-five miles from north to south, and perhaps thirty-five to fifty from east to west; a very convenient little desert, easily manageable, one might suppose, for any naturalist, who, with inborn love of adventure, starts out in search of the wilderness to find scenes and pastures new.

A year ago in this presence, it may be recalled, the present speaker, by aid of photographic illustrations, attempted to sketch the relations obtaining, as would appear, between the geology of the desert and its flora; in the present paper it is intended briefly to resume the earlier argument with such added reflections as may be suggested by present conditions and by recent renewed acquaintance with the problem.

The desert of Alamogordo or Tularosa is a great plain, not unmarked, however, by singular topographic inequalities later on to be described. Only the most casual geologic examination is sufficient to show that the plain floor corresponds stratigraphically with the beds in some places exposed at or near the tops

of the surrounding mountains, in any case far up their flanks. On the east especially limestones of carboniferous age rise sheer some 1,000 feet or more straight up from the desert floor, and are again capped by other strata only at length, perhaps 1,000 feet higher, surmounted by materials correspondent with those in the level of the plain. On the west the same thing is true; but more emphasized still is the difference in level between segments of corresponding strata. Here the weird Organ mountains break the horizon by upthrust spires and pinnacles of granite which to some early voyageur crossing these dusty plains suggested the pipes and architecture of some far-off organ, and the mountains so were named; but upturned granite means that the sedimentary rocks are here further uplifted still than on the eastern side, so that we quickly find ourselves in presence of vast parallel faults and our desert lies thus between their giant walls. It is as half the region between this city* and New York should suddenly sink two or three thousand feet, or, what is the same thing, it is as if the several thousand feet of difference in level were brought about by the depression of the included area, and the simultaneous elevation of the sides. At any rate the desert plain of the Alamogordo or Tularosa sands is simply the upper surface of a gigantic block of the earth's crust that sank some time subsequent to the deposition of the Jura-Trias and the earlier cretaceous strata of this western world. These strata include, as we know, the famous "red beds" which tinge the mountains of half the continent, the red beds with all their gypsums, marls, and salts of every description. Accordingly, as a result of this faulting, our desert has for its foundation everywhere great fields of gypsum, often for long distances wide-exposed, sometimes thinly veiled by loosened sand, sometimes deep buried by vast deposits of wine-red marls and clays, or covered anon by the products of erosion, whether by water or by wind. The waters from the mountain snows have brought their débris; the winds of the desert have come with their burden, but nowhere has such transportation traversed the desert borders, at least in recent times; there are to-day no excurrent nor percurrent streams; the winds die along the mountain walls and the waters sink in the dessicated sands.

* Philadelphia.

But this is not all. This great sunken block of earth's crust seems itself to have been cracked again and again; there are secondary faults, and along the line of one of these thinner or weaker places the subterranean energies of the world have some time found emergence. Floods of lava welled up in the midst of the desert, and fountains of fire streamed along the ground, following existent topography for miles and miles, now narrowing to dimensions measured by rods between low ranges of hills, now widening for miles across the broader valleys, only to lie at last a vast field of blackened cinder, slowly disintegrated by the desert storms. This is one of the most peculiar topographic features of the whole desert. As things terrestrial go, this is a recent phenomenon. The age of the lava may be measured by centuries, a few thousand years, it would seem, at most. The surface over which it poured was a friable, marly soil. As the floods cooled, the mass cracked and gaped in every direction. Rains descending upon the surface sank to the ground below and shaped for themselves channels. The lava so undermined has fallen into a tumbled ruin of weirdness and confusion, indescribable, impassable.

The lava constitutes one of the features of this remarkable desert; there is yet another. Along the western border, partly by erosion, partly uncovered by the western winds, great bodies of gypsum lie exposed. As this slowly disintegrates the wind gathers the particles set free and bears them eastward; the famous white sands, covering township after township with drifted mineral white as snow. Vast windrows shifting slowly with every storm, and forever reinforced by the unceasing contributions of the west, mark the landscape over several hundred square miles, unique, intact, forever changing, yet the same forever.

Added to these peculiar and special topographic details of this surprising desert we have, of course, those less noteworthy, the common every-day features of desert make-up: we have mountain slopes, rocky fields, and hillsides, eroded valleys, marshy sinks, where lose themselves the vanishing torrential streams; wide plains of marly clay, belts of sand-dunes, red sands, yellow sands, also shifting and moving, but better subservient to the

vegetation of the region; these present simply vast fields of low hills or hummocks ten to twenty feet in height, separated on every side by tortuous valleys, winding in labyrinthine fashion, wind-swept hard and bare.

One other topographic feature must yet be added to complete our picture. The forces of erosion even along the mountain walls have kept pace fairly well, at least, with the changes in level. Great cañons break back even through the hard, encrinitic limestones, dividing again and again where the waters have carved the rugged pathway by which the explorer may now reach the mountain summit. The result of this erosion forms a wide talus around the desert, spreading great fan-shaped deposits at the mouth of the cañon, where immense blocks and boulders choke the exit, succeeded by ever smaller rocks and pebbles farther out until at length only the finest silt is swept along from the widened margin far across the almost perfectly level plain.

Now it is evidently needless to say to every wisest man in an ecologically minded audience such as this, that every one of these peculiar topographic features, whether special or not, will display its own peculiar flora. True, this is not always the case; this desert must be studied in its entirety, and it will require months of patient research to even sketch its far-reaching problems. As a whole the flora may be said to be that of our western arid regions generally, and yet, after all, it is not just like that of any other region, north, south, east or west; not that it has peculiar species perhaps, but that it has its own particular groups of species.

Two factors, and two alone, as it seems to me, determine the phytology of this desert; the one, difference in the constitution of the soil, referable to its geologic history, the other difference in level, referable to the same initiative. Thus there is a peculiar flora on the sands whether white or red, another on the silted plains less liable to transportation by the wind, another where the salts emerge, whether in briny springs and fountains or as crystals whitening the surface of the ground; another for the mountain shelves, and still another for their far-off summits.

The El Paso Northeastern railway passes the desert on its

eastern side. There are two stations on the line where for several miles in every direction the surface is a red-brown sand. One of these stations has been by the railroad people appropriately named Desert, the other is Escondida. The level of the two stations is the same, 4,000 feet, and the flora is identical, although the points are thirty miles apart. Each, however, is by itself unique and entirely separate from the other. The dominant species is *Yucca radiosa*, so much so that these points are called the yucca desert. Of course, the almost ubiquitous mesquite is there and *Atriplex canescens* and *Artemisia* —— sp.? There are other species to be sure, such as forms of *Chrysothamnus* and *Ephedra*, but the plants first named give to the plain its character as far as vegetation goes, and in topography as well: they not only thrive here and come to abundant flower and fruit, but they hold these peculiar sands otherwise driven about the world by desert winds.

Now it is a remarkable fact that the white sands, thirty or forty miles off to the northeast, exhibit an almost identical flora. The student hastens across the intervening desert to meet that shining wall, expecting to find all things new; but, behold, the white sands are *sands* first of all rather than anything else. Whatever their chemistry, and they have their peculiar problem for the chemist, only a vegetation that can endure a moving, shifting terrene, can flourish here. The white sands form accordingly part of the Yucca desert. Their relation to vegetation is almost purely physical, but they exhibit some peculiarities. They are gypsum, as everybody knows,* but while they move as other sands, they must be compared with wet sands. The vast drifts, thirty to fifty feet in height, are *moist* often to within a few inches of the surface, and are so

*The following analysis of this material has been kindly furnished me by Dr. L. W. Andrews of the Mallinckrodt Chemical Works, St. Louis:

Calcium sulphate, $CaSO_4$	77.64	per cent.
Water, H_2O	20.55	"
Calcium carbonate, $CaCO_3$	0.95	"
Silica and undetermined, SiO_2, etc	0.86	"
	100.00	"

compactly driven that one may walk upon the solid surface with comparative ease. A white wall like to the appearance of marble is moving slowly eastward, whelming all vegetation as it goes, some of which, able to grow through the encroaching mass, persists so that all the plants now appearing on the surface, so far as examined, are anchored by lengthened stems or roots to the underlying older soil. The same yucca that appears at Escondida here emerges sometimes by green tips from a snow-white drift twenty feet in height, or anon, seems to crown triumphantly some lower mound. The mesquite holds on, in some places a desperate fight, and certain species of *Rhus*, *R. aromatica* and *R. trilobata*, perhaps, maintain a perilous existence out over the whole region, sometimes even on the summits of the highest knolls. These sumacs are the characteristic species of the white sands.

But let us turn north. A journey of fifteen or twenty miles brings us to the black wall of the lava flow. This is a fearful region. The Mexicans call it *mal pais*, "bad country"; giant floods whose waves are stone, fields and fissures, caverns, holes, pits and wells, alternating with tilted slopes, knife-edge culms and ridges, make a topography weird, impassable, fascinating because so unapproachable. Yet the *mal pais* is covered with vegetation. Of course, the vegetation changes, but by no means as one might easily suppose. Here is no new species, no variety of a species when the desert is studied as a whole. The change is correspondent to a change in level. The lava beds are high, and they are crowned with the flora of their own altitude. We shall meet it on the foothills of all the mountains we presently ascend. Here is no alteration of soil, for the only soil is that deposited by the wind, the lava itself perfectly intractable. Here are the familiar mountain cedar, *Juniperus occidentalis;* cholla, sometimes twelve or fifteen feet high, where, springing in some ragged well-hole, it seems to peer out above the sooty walls that hem it in; here is the mountain barberry. Even the nut pine, *Pinus edulis*, has mistaken these pitchy steeps for the clayey flanks of its usual mountain fastness, and now and then rivals the cedar in its hold upon the jagged upturned edges of these flinty sheets. Even the lava beds have

not apparently affected the general character of the desert flora.

At the south ends of these black fields, however, emerge great springs. Here all the plain is saturated with salt and alkali, and here is a peculiar flora conditioned by this fact. The waters emerge almost from the edge of the lava sheets, and tufts of *Suæda* and *Allenrolfia* are set close against the lava wall. This is ideal; this we should expect and here it is.

The sands and the lava lie in the middle of our desert. If we take these as a starting point and move toward the summit of the mountains, the successive belts of vegetation gradually shape themselves so that we learn presently to identify them by their color. A plain below the general level is gray, grass-covered, with here and there a bunch of ephedra or nopal, no yuccas, no atriplex, no other forms of cactus. As the terrene rises to the silt plain thickets of cholla alternate with mesquite and the crucifixion thorn; not that other species do not occur, but these are dominant, give to the belt its character and color. A little further mountainward and we reach the *Covillea tridentata*, ever in bloom, which lies as a girdle of green and gold around the whole base of the mountain range, visible for miles and marking for us the limits of the talus with an exactness that is remarkable. Beyond the covillea belt come the cacti as the terrene becomes more rocky; *Mamillaria*, with its species numerous and varied, the unique but widely distributed ocatilla, the prickly pear, often in giant form—all these cover the rocky slopes that lead up to the steeper walls of paleozoic rocks. Sometimes, where a shelf occurs, and the bare limestone forms a flat, mesa-like field, the yuccas come back, but not the Escondida form, with *Agave parryi*, and abundant ocatilla, while in the rocky defile below, locked amid gigantic boulders, now on their tardy journey to the talus plain, the creamy flowers and fruit of dasyliria lift their glorious spikes, the envy and vexation of the photographer.

The strata of the lower carboniferous limestones now confront us; crystalline, encrinitic and exceedingly hard, rising often hundreds of feet sheer up and down. But these dry walls likewise have their flora. *Mamillaria micromeris* matches with

its hoary spheres the weathered stone or lights it up betimes with scarlet bloom, and *Notholæna sinuata* fills with sombre tufts every shattered crevice.

But the upper members of the carboniferous are much softer and, amenable to erosion, present a gentler, flowing topography. These slopes are everywhere clothed with oak, not trees, indeed far from it; low dense shrubs, the so-called shin-oak, *Quercus gambellii* and *Quercus gunnisoni*. These two species form pale green belts around the mountains, and are recognized easily, distinguishable for miles. These species indeed form a sort of phytographic border land; all below is desert; all above is forest; for above stands, or lately stood, one of the fairest bits of woodland in the United States, and that means in the world. But this forest is again in large measure conformable to geologic structure, its distribution determined by the history of what lies beneath.

As we ascend the mountain, passing all the carboniferous limestones, sands, chalk-beds and shales, we presently encounter the "red beds" already mentioned, the most remarkable geological horizon in the country, familiar to every student of our central mountains, noted even by the ordinary tourist, the same wherever found—in Utah, Colorado, the Black Hills of South Dakota, and here again in these far-off mountains of the Mexican border, the same vast gypsum-burdened deposits of clay and shale and sand. The red beds yield easily to erosion. The washings from their wasted flanks have tinged the desert far below, and reddened the walls of every rocky cañon on the way. Sloping terraces and flat-topped hills afford a soil rocky but not infertile, supporting once more its own peculiar vegetation. Here are still the shin-oaks, it is true, but all overshadowed by other nobler trees; here is *Berberis trifoliolata*, the Texan barberry; here is *Pinus edulis*, Engelmann's nut pine, and most characteristic and perfect of all, here stands *Juniperus pachyphlœum*, the mountain juniper, great forests of it, ancient trees betimes, all comparatively low, but with giant trunks six or eight feet in diameter; these time-defying cedars are the trees of the red beds. With the junipers, especially as we pass their upper limits and come out upon the calcareous cretaceous swells and

plains, occur another oak or two. The soils are now remarkably rich in lime. The waters that fall on the higher mountain levels escape above the red bed shales, but so impregnated with lime that they actually form a new stony deposit often for a distance of many rods about the point of exit. On these calcareous soils stands now the forest, along the very summit of the mountain, nine thousand feet above sea-level a magnificent forest of spruce and pine and fir: *Pseudotsuga douglasii*, the Douglas spruce, five or six feet in thickness; *Abies concolor*; *Pinus ponderosa* in beautiful perfection of its immortal youth; *Pinus flexilis* at its very best; a typical Oregon forest six or eight miles wide and some twenty long, crowning the summit of this isolated mountain peak in the midst of the deserts of southern New Mexico, for, as everybody knows, these are in general species of the forest of the far Pacific coast. As one stands now at last thus at the very summit of his problem, and from some promontory rock of vantage looks out upon the vast plain thus mountain-girt, the indescribable beauty of the scene must first impress him. Far to the west lie the San Andreas, the Organ and the Oscuro ranges, a long low wall, grey and solid, its serrate summits indentured in the azure sky; below, the plain, brilliantly lighted, soft and brown and lucid, save as the *mal pais* stretches its blackness as a bar sinister across the northern end, while away to the south the gypsum desert seems a cloud of snow beneath our feet, more brilliant than that evanescent whiteness that floats in the deep blue far above—the one the strange counterpart of the other; all is so silent, so changeless, and so fair!

But just now we heed not the beauty of the landscape; other thoughts come crowding upon the observer, all equally insistent and impressive. Evidence of enormous physical change thrusts itself upon our astonished attention; not the sunken desert itself alone, that great block already described, but the denuded and sundered mountain walls, the great cañons that stretch back for miles, cut down through even the solid limestones at the mountain base—a process vast and old. Once the cretaceous sea rolled here, and when it retreated here were beds of limestone hundreds of feet thick. Where are they now?

Only here and there a remnant on the mountain summit; the desert is covered with their débris almost to distant sea.

Nor less is one impressed by the slowness of all this topographic change. There is evidence of violence, suddenness, nowhere, save in the *mal pais*, which is local, recent, and does not affect the general problem. The moving currents of the air, the soft ministrations of the summer shower, the melting winter snows, have carved these mountains, are sculpturing them to-day. Those columnar whirlwinds that even now like dancing dervishes chase each other across the plain, are shaping anew the desert; that thin cloud that hangs yonder like a banner from the mountain top is a rainstorm, changing even now the general altitude of the range.

But once again; as we look out thus from the summit of our problem we are impressed with still another fact more far-reaching, more splendid still. The whole living covering of the world, the vegetative garment of the desert and the mountain, conforms exactly to the surface, to soil and level, no doubt with an exactness that we have only begun to guess or understand. There is a mathematical line that limits the distribution of every plant, but that line forever shifts and varies. The topography varies, except the *mal pais*, by changes so slight, so delicate, as to be imperceptible to eyes unskilled, and with the topography varies its covering of life. Let us say first that these topographic changes will change the limits of distribution. Once the sands cover the silt plains, and the grasses will vanish while yucca and artemisia succeed. Widen the talus and covillea will stretch farther its golden scepter. But the problem runs far deeper than this. As the face of the world undergoes these delicate, subtle changes, the plant responds in something far more than shifting distribution. A plant, as every student of botany well knows, is the most plastic sort of an organism in the world, responding in every sort of way to its environment. We who study the microscopic structure of the humblest plants understand the limitless possibilities here. When we reflect that the suppression of a single cell at the critical moment may change the direction of an axis or alter the contour of a leaf, it is hard to set too high an estimate upon the possible response made by

a simple plant to environmental variations, however delicate. We who study the physiology of the plant, peer into its changing cells, and strive in imagination to reproduce the marvellously intricate reactions—physical, chemical—that forever shift and play within those narrow limits—we need not be told that every vegetable cell has in it opportunities a thousandfold to match and meet all the subtle changes suggested by the slow-creeping but implacable forces that work out the physiognomy of this time-worn earth. A little more calcium here, a little more phosphorus there, sulphates, nitrates, and the rest, and the thing is done. Nay, when we even think of the form in which all energy comes from yon distant sun, and the delicate machinery on which it plays, we need seek no further occasion for the intervention of every sort of outer cosmic force. Not a tree on all the Iowa prairies but shows in its every lineament, in its very expression, a response to the Iowa environment; and so, we may be sure, every desert plant records in its present form and stature all the affirmations, all the responses it has made in all the centuries to the bidding, the silent bidding, the most gentle coaxing, of the world external. For, note you, the call for change at any given instant has not been great; the slow upheaval of these mountains, their peaceful gentle removal by the winds and rain; that is all; but that has changed and is changing the living world. Where the terrestrial call is rude or sudden, response there is none. The lava beds show no single characteristic species. Their flora is simply that of their own rocky level. Nor could here any sudden initiative on the part of the plant avail. The adaptation is absolute now, and to vary save as the environment varies would simply invite disaster. As well the tadpole suddenly assume lungs or the lizard put on feathers.

Nor is this all. Our desert as it lies shining here before us is but a fraction of that wider, vaster desert that covers all the south and west. Across the Organ and San Andreas yonder is another desert exactly comparable to that we study; all Arizona, southern California, Sonora, Chihuahua, much the same; here and there a mountain summit tufted with forest, western in type, high slopes thinly clad with stunted juniper, benches of

covillea, wide low plains covered with mesquite, with yucca and cactus and all the less noble plants that stand between; and our problem widens, becomes vast as the continent, and any answer that we make must be far-reaching as the flora of a world.

Our desert lies shining here before us; but not one of these plants except the cactus is in broader sense unique; each has its kin rising in happier fields to fairer fortune. The yuccas are lilies, but lilies bloom in Bermuda and in Teneriffe, and in every most fertile garden of the world. The mesquite is a prosopis, but the genus *Prosopis* shows many a handsome forest tree, and even the mesquite in the Arizona valley, where conditions are less hard, rises a forest with trees fifty feet in height. The cactus, as I read it, with undifferentiated floral leaves and abundant sporophylls, is an ancient adaptation to an ancient desert, possibly pre-cretaceous, and takes possession of the world just so fast as the world becomes desert; unstable in cultivation, not because new, but because reversionary.

I do not mean to say necessarily that the Alamogordo desert flora has had its origin where it stands, although such a contingency is not impossible of thought. Had this been the only desert on the continent its flora is as might have been expected. But there are a hundred similar intra-montane regions whose geologic history is the same. These have in similar fashion originally shaped a flora each for itself. No doubt once similar conditions are set up in regions at first unlike, an exchange of species may take place. American cacti are at home in the deserts of Europe, and the Russian thistle flourishes on Dakota plains.

The desert lies shining here before us, changing forever, but all its changes are of imperceptible delicacy and slowness. Its methods would seem not different from those by which nature has from the first essayed the education of the vegetable world. Between salt water and fresh all conditions offer by infinitesimal shadings where the rivers meet the sea; thus green plants first emerged from ocean; all conditions from shore-line low-water mark to dry land; thus the plants at length sat on the shore, wet only by tides or by the gentle rain; all conditions of level by which the plants occupy the kingdom of the upper air;

all conditions of spore-union by which they meet at length the problem of aerial fertilization; so that while sports there may be among plants outside the pale of cultivation, nevertheless they must always be within limits set as result of more gentle changes effected by the slow, and, for the most part, exquisitely delicate transformations which make up the history of the planet. Given a desert flora, a cactus flora, for instance, and there may be endless species-making, by sport if you will, or otherwise, but in every case a cactus; but the cactus itself is the child of continental movements which brought about some old-time, perhaps cretaceous desert.

Our desert lies shining before us; it is old and silent: would you know its secret, read the rocky records that lie behind, around, beneath, and be assured that once the story of yesterday were understood the facts of to-day would ask no wider explanation. The physical forces of this world still drive the loom that weaves the web of life. Before the loom the unseen weaver sits, guiding her web that passes to an endless roll, changing withal the width, the pattern, as conditions rise. Changes her arabesque, it is for cause; changes it not, it is alike for cause; and if at intervals as we watch, anon new figures rise, may it not be but the return of some earlier triumphant cycle that here begins anew, evident enough in cause and feature were once that giant scroll unrolled, or were her watchers more patient, more enduring. Alas, in presence of this mighty loom what fleeting, evanescent interpreters are we!

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ADDRESS

BY

SIMEON E. BALDWIN,

VICE-PRESIDENT AND CHAIRMAN OF SECTION I FOR 1904.

THE MODERN "DROIT D'AUBAINE."

One of the dark spots in the dark and middle ages is the treatment of foreigners. Was a ship wrecked upon the French coast? What was saved was saved for the seigneur who owned the shore, or his overlord, the king. The lading and the crew were alike his, to dispose of as he would. If the sailors were uncivil enough to set up a claim to the wreckage, he could kill them. If he preferred, he could sell them as slaves. It was his right—the *droit de naufrage.*

It was on the same principle that down to modern times, if a man happened to die while traveling or living abroad, his estate, in many countries of Europe, was seized and kept by the lord of the manor or the sovereign of the land. His will was disregarded. His natural heirs, unless born on the soil or naturalized citizens, were set aside. All that he left belonged to the governing power.

Quite naturally, as trade between nations became more considerable, the countries which retained this *droit d'aubaine* in its full vigor and severity found few merchants ready to bring cargoes to their ports. The result was successive modifications of the system. Certain trading centers were exempted from its operation. Naturalization was to be easily had by traders, and when obtained relieved them from subjection to it. Government securities held by any foreigners passed to their natural successors or by will.*

* Merlin. *Répertoire de Jurisprudence*, Aubaine, No. VII.

The interest of the government called for such relaxations of its so-called right, and the king who relaxed it most, because he saw most clearly that it was for his advantage so to do, found the foreign trade of his dominions grow most rapidly and settle itself upon the most stable footing.

The *droit de naufrage* was the first to disappear. The humaner law of the Christian emperors of Rome,* followed by the Visigoths in Spain in the seventh century,† and enforced in the twelfth by the laws of Oleron,‡ appealed successfully to the awakening conscience of the modern world.

Anything in the nature of a *droit d'aubaine* had also been denounced in the *Corpus Juris* of Roman law.§ As time went on, its range became more and more contracted, and by the close of the middle ages it had become, so far as personal property was concerned, generally softened in practice to what was called a *jus detractus*,‖ except in case of those dying intestate and without known heirs.

As respects real estate in one country owned by citizens of another, the sovereign of the former might still claim it as his own; but it was because political considerations were deemed to require it. In a nation whose constitution of government or family institutions rest on a landed electorate or aristocracy, it is right to debar foreigners from holding what might enable them to influence directly the conduct of government. This is the defence of the system of escheats under the common law of England, abolished there in 1870,¶ but which still lingers on in many of the United States.

It took the flames of revolution to burn the *droit d'aubaine* out of the institutions of France, and for a time, under Napoleon, it was restored as respects citizens of any nation which yet might retain it.**

* Code, XI, iii, 5, *de naufragiis*, 1. Cf. Digest, XLIX, xv, *de captivis et de postliminio*, 5, 2.

† V, 5, *Corpus Juris Germanici*, 2001.

‡ Art. 25, 26. 1 Peters' Admiralty Decisions, xli, note.

§ Code, VI, lix, *Communia de Successionibus*, 10.

‖ Fiore, Droit International Privé, I, Preliminaries, ch. II.

¶ With a proviso that an alien acquiring land should gain no political rights thereby.

** Civil Code, Arts. 726, 912; Law of July 14, 1819.

Under the *jus detractus*, the sovereign within whose dominions a foreigner chanced to die no longer claimed title to all his goods, unless no will and no next of kin were anywhere to be found.* He was content with part, and, after making this "detraction," or, as we should say, "subtraction," gave up the rest to the natural heirs, or those to whom it might have been bequeathed by will.

So if a subject of his own should die, leaving a will in favor of foreigners, or having only foreign heirs, they were admitted to the succession, subject to a detraction of the same kind.

The percentages retained, in either case, as time went on, became more and more moderate. Reciprocal conventions between different nations for their regulation in this respect were not uncommon. Five per cent., which was the duty imposed in the first inheritance tax law of Rome—the *vicesima hereditatum et legatorum* decreed by Augustus—became not an unusual rate to fix by such an agreement in the latter half of the eighteenth century.†

So far as concerns such a tax on foreigners who come to take away what forms part of the wealth of a nation, it is, if the rate be moderate, in no sense inequitable. But for one sovereign to tax what belongs to the wealth of another bears a different aspect. It is the *droit d'aubaine* in a new dress and a politer form. It even asserts itself over a larger field.

The ancient *droit d'aubaine* was exerted almost exclusively in the case of foreigners dying within the realm; never except over tangible property found within it, belonging to their estates. The modern *droit d'aubaine* fastens upon all their property so found, whether tangible or intangible, and this whether they

* If there be no better claim, that of the sovereign within whose territory property left by the dead is found is clearly good. The leading powers of continental Europe, at their Conference held at the Hague in 1904, agreed (subject to the principle of reciprocity) to the mutual recognition of this right and the denial of any other in the nature of escheat or *aubaine*. *Projet d'un Convention sur les conflits de lois en matière de succession et de testaments*, Art. II. Revue de Droit International Privé, VI, 348. Sixteen European powers and also Japan agreed to and signed this project June 7, 1904.

† See Merlin, *Répertoire de Jurisprudence*, Détraction.

died within the realm, or in their own country, out of which perhaps they had never set their foot.

In the first of the treaties of the United States with foreign powers their right to do even this, with respect to estate left within their jurisdiction by an American citizen, was excluded, provided a reciprocal exemption were assured in return. This was that negotiated with France in 1778 (and abrogated by Congress in 1798), Art. XI of which read thus:

"The subjects and inhabitants of the said United States, or any one of them, shall not be reputed aubains in France, and consequently shall be exempted from the droit d'aubaine, or other similar duty, under what name soever. They may by testament, donation, or otherwise, dispose of their goods, moveable and immoveable, in favour of such persons as to them shall seem good, and their heirs, subjects of the said United States, residing whether in France or elsewhere, may succeed them ab intestat, without being obliged to obtain letters of naturalization, and without having the effect of this concession contested or impeded under pretext of any rights or prerogative of provinces, cities, or private persons; and the said heirs, whether such by particular title, or ab intestat, shall be exempt from all duty called droit de detraction, or other duty of the same king, saving nevertheless the local rights or duties as much and as long as similar ones are not established by the United States, or any of them. The subjects of the Most Christian King shall enjoy on their part, in all the dominions of the said States, an entire and perfect reciprocity relative to the stipulations contained in the present article, but it is at the same time agreed that its contents shall not affect the laws made, or that may be made hereafter in France against emigrations, which shall remain in all their force and vigour, and the United States on their part, or any of them, shall be at liberty to enact such laws relative to that matter as to them shall seem proper."*

Among our later treaties with like or broader provisions may be mentioned those with Sweden of 1783, with Würtemburg of 1844, with Saxony of 1845,† with France of 1853, with Germany

* 2 U. S. Rev. Stat., 206.

† *Ibid.*, 723, 809, 690.

of 1876, and with Great Britain of 1900. The exemptions secured by those of the older type related only to property left in or subject to the control of one country by citizens of the other, at the time of their decease. They did not extend to interests of citizens of one in successions to estates of citizens of the other, which are in course of administration in the courts of the latter.* The later conventions do extend to these.†

The provision in the Constitution of the United States, securing to citizens of one State the ordinary privileges common to citizens of any other into which they may go, gives to our people a somewhat similar measure of security. But it has not prevented the building up, slowly at first, rapidly of late, of a network of State tax-laws, imposing succession duties on property left within the State by deceased citizens of other States, without regard to whether their representatives have already paid similar duties at home, and so are subjected to a double burden for a single privilege.

Within limits no economist will question the propriety of laying taxes on bequests and inheritances. They are collected with ease and reasonable certainty. They fall upon something which the taxpayer has never yet enjoyed and the diminution of which he therefore does not fully miss. The goose, to follow Colbert's maxim, is plucked so as to get the most feathers with the least squealing, and almost with none. Live goose feathers, indeed, are not required. The real victim is dead.

As to whether the form to be preferred is that of a probate duty, a stamp duty, a tax on the privilege of transmission, or a tax on the privilege of receiving what is transmitted, opinions may fairly differ.

Death duties were first imposed in Great Britain towards the close of the eighteenth century. Under the system developed there the movable property, wherever situated, of a person dying domiciled in the kingdom is subject to them, but not such property left in the kingdom by one who died domiciled in any other country.‡

* Frederickson *v.* Louisiana, 23 Howard's Reports, 445.

† Geofroy *v.* Riggs, 133 United States Reports, 258.

‡ Wharton's Private International Law, §§80, *a*, 643. As to probate duties, the statutes make a different provision. Fernandes' Executors' Case, 5 Chancery Appeals, 314.

What is taxed is not the interest in property to which some person succeeds because of the death of its former owner, and not property at all, but the interest in property which the former owner lost upon his death, and which would have ceased to exist altogether had not the State seen fit to prolong it in favor of those whom it recognizes as entitled to the succession.

It is this prolongation or revival of an estate which death has destroyed—a prolongation by force of no natural law, but only of the will of the political sovereign, that justifies a succession tax.*

The earliest American succession duties were levied by Congress in 1797, and took the form of a stamp tax on receipts for legacies.

Pennsylvania was the first State to impose them. She did this in 1826, but the law did not extend to goods of those not inhabitants of the State, which had been temporarily left there.† They were left untouched in deference to the ancient maxim of private international law, *mobilia personam sequuntur.*

It was this maxim that had always been the chief measure of the jurisdiction of courts over the settlement of the estates of the dead. The estate had been treated as a kind of a survival of the person who once held and administered it. It therefore had its principal seat in the place which had been his home. Transfers of goods *inter vivos*, founded on contract, may be regulated by the law of the place of transfer; but transfers of the whole of a man's goods, upon his death, by force or permission of law, must, in fairness to all concerned, be regulated by the law to which he was subject. In England and America it is settled that this is the law of his domicil.

Those to whom that law gives them acquire a good title the world over. There is but one succession to a dead man's goods, and that takes place once for all when he dies and where he dwelt.‡ This law, which protected him while they were his, and directs the course of their devolution when he is no more,

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* Knowlton *v.* Moore, 178 U. S. Reports, 41, 49, 55.

† Orcutt's Appeal, 97 Pa. State Reports, 179.

‡ Cross *v.* United States Trust Co., 131 N. Y. Reports, 330; 30 Northeastern Reporter, 125; Frothingham *v.* Shaw, 175 Mass. Reports, 59; 55 Northeastern Reporter, 623.

may justly tax those who benefit by their devolution, irrespective of the place of their residence, or of that where the goods may chance to be found.

Our American succession taxes, like those of England, are everywhere, when imposed by the State where the deceased had his home, measured by a percentage of the value of all his goods, wherever situated, and all his real estate situated within the State, subject to some exemption of moderate amount.

But during the last twenty or thirty years the States have begun to go farther and charge a like percentage on all goods of a non-resident, which may be subject to their power.

There is no legal objection to this.

It is not double taxation within the meaning of any constitutional prohibition. In law, double taxation occurs only when the same sovereign taxes the same thing twice. But aside from this, a law of the kind now in question does not tax the same thing which had been taxed before. The sovereign of the domicil only can tax the succession to goods, because the succession takes place, once for all, under his laws and in his territory. What the sovereign of the *situs* of goods left by a foreign decedent taxes is not the succession to them, and not the goods themselves, but the privilege of taking them away, under the title derived from that succession.* The title is unquestionable, and unquestioned, but the right of the owner to avail himself of it in foreign territory depends on the comity of the foreign sovereign, who if he permits a transfer can prescribe the terms.†

Nor is a tax so imposed any infringement of the privileges and immunities of citizens of other States, for they are treated precisely as those of the State by authority of which the tax is laid.

It is an infringement of a maxim of private international law; but such maxims may be set aside by any political sovereign who thinks it for his interest to disregard them. Our courts, in the absence of legislation to the contrary, treat the doctrines

* Foelix, Droit International Privé, I, §9.

† Magoun *v.* Illinois Trust & Savings Bank, 170 U. S. Reports, 283, 288; Dammert *v.* Osborn, 141 N. Y. Reports, 564; 35 Northeastern Reporter, 407.

of private international law as part of the common or unwritten law, but it is only in the absence of legislation to the contrary. A statute can always abrogate unwritten law.

Not only is it lawful but in many cases it seems not unjust for a sovereign to tax the succession on goods within his dominions, left by a foreigner. If they were not simply in transit, but had been there so long as to become part of the wealth of the realm and to share in the settled protection of the government, they were subject to taxation for it when the owner was alive; and as the new successors must come there for possession, and can only dispossess those in whose hands they may be left by force of this sovereign's laws, and if need be, by process from his courts, they cannot seriously complain if he asserts a right to tax them for what they get.

So is it also in the case of intangible property when that has been long placed by the owner in the hands of agents in a foreign country to manage and invest.*

But while such successions can be taxed by the sovereign of the domicil and taxed again by the sovereign of the *situs*, it is quite another question whether they should be.

Had we adhered inflexibly to the universal maxim of ancient law—*mobilia personam sequuntur*—the results would unquestionably have been far better. Every State laying a succession tax lays as high a one as it deems best to impose. It selects a certain subject for taxation and presumably exacts all that it can fairly be made to yield. For another State to tax the same subject again, therefore, is to impose a heavier burden than it ought to bear.

If the State in which the decedent's estate is settled collects the only duty, and this were the universal rule, nothing in the long run could be lost by any other State. On the average one would profit as much as another by uniformity of rule. While every State would let the citizens of another withdraw the property of the dead untaxed from its territory, its own citizens, as

* New Orleans *v.* Stempel, 175 U. S. Reports, 309; *In re* Lewis' Estate, 203 Pa. State Reports, 211; 52 Atlantic Reporter, 205; *In re* Romaine, 127 N. Y. Reports, 88; 27 Northeastern Reporter, 759; 12 Lawyers' Reports Annotated, 401.

heirs or legatees, would bring back with equal freedom property of the same kind from all the rest.

As a matter of fact and history our legislatures in this matter have claimed the benefit of the rule *mobilia personam sequuntur* whenever it served their purpose to invoke it, and set it aside whenever it served their purpose to disregard it.

The test of taxability, as respects a succession to intangible property of a non-resident, may be said to be this: Whatever may be its form, if it have a money value and, although it may be fully owned by and fully transferable by the successor, cannot be enforced or converted into money contrary to the will of the person against whom the right of property exists, without coming into the State imposing the tax, then it is property within that State and taxable as such.*

If a citizen of Texas die, having money on deposit in a New York bank, a succession tax may be levied on it by New York as well as by Texas.† If he leave bonds in his box in the vaults of a New York Safe Deposit company, and they are due from a citizen or corporation of New York, both States can exact the same percentage on these. If the bonds are those of a person or corporation of a third State, they may be subject to three taxes. The State where he lived lays a succession tax on their full value because he was subject to its power. The State in which the bonds are deposited for safe-keeping lays a tax of the same, or perhaps greater amount, on their full value, because the bonds are in its hands, and it will not let them go without receiving it. The State where the debtor who signed the bonds belongs can also levy as large a tax, because it can refuse any remedy in its courts for their collection except on such terms as it may itself lay down. So in the case of corporation stocks, the shareholder's estate pays one succession tax to the State of which he was a citizen, and those who succeed to him pay

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* *In re* Whiting's Estate, 150 N. Y. Reports, 27; 44 Northeastern Reporter, 715; 34 Lawyers' Reports Annotated, 322; 55 Am. State Reports, 640: *In re* Houdayer's Estate, 150 N. Y. Reports, 37; 44 Northeastern Reporter, 718; 34 Lawyers' Reports Annotated, 235; 55 Am. State Reports, 642: Buck *v.* Beach, Indiana Reports, 71 Northeastern Reporter, 962.

† Blackstone *v.* Miller, 188 U. S. Reports, 189.

another to the State chartering the corporation, and possibly a third to a State in which the stock certificates were kept;* for by holding on to them till such tax were paid it could put a serious obstacle in the way of their sale and transfer.

It is to be remembered also that there is no constitutional limit to the rate of taxation. In Holland in the eighteenth century, collateral successions falling to the remoter kindred were subject to a deduction in favor of the State of thirty per cent.† Three such taxes would leave of the oyster little but the shell.

In 1898, during the war with Spain, Congress also levied an inheritance tax, and the burden on the succession was heavier still until the repeal of that measure a few years afterwards. It did not, however, apply to personal property here passing on the death of the owner to citizens of another country.‡

The results of this condition of multiple taxation are rapidly becoming apparent.

Capitalists are beginning to center their investments at home. They prefer to put their money in domestic stocks and securities, for these, upon their death, will be taxable but once. They are inquiring in which States, out of their own, it is safest to make or maintain investments; that is, in which States there are either no inheritance-tax laws or no inequitable ones. They are organizing corporations, which never die, to hold their property. They are taking title jointly with their wives or children, so that death leaves the survivor the sole owner.

It has been said that a country should never tax anything of value which, if not taxed, would be likely to find its way there, and which, if taxed, would be able to escape from its power.§

The American people are quick-witted. It will not take long for all of them to learn in which of the States, they can and in which they cannot do business without subjecting their property, in case of death, to what is practically double taxation.

Wall Street is to-day the financial center of a great stretch of

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* *In re* Bronson, 150 N. Y. Reports, 1; 44 Northeastern Reporter, 707.

† Adam Smith, Wealth of Nations, III, Book V, 326.

‡ Eidman *v.* Martinez, 184 U. S. Reports, 578.

§ See David A. Wells on Taxation, Cyclop. of Political Science, *ad fin.*

American territory. The trust companies, the banks, and the safety deposit vaults of New York City hold vast amounts of moneys, bonds, and commercial paper belonging to residents of other States, who have left them there for security, or to use them for investment or re-investment. Their owners are taxable on them where they live. Their estates are taxable on them there, if they die. Let those men once fully understand that their estates would be also taxable on them in New York, and it will not be long before their investments take a new shape or are put under different keeping. New Jersey is already profiting by this.

An inheritance tax by a State upon what is left by its own inhabitants is right and just. It is right and just to place it upon real estate situated within its territory, and belonging to an estate of a dead man. It may be not unfair and not impolitic to place it upon tangible personal property of such an estate which has been statedly kept within its territory, and on which no such tax is imposed in the State or country to which its former owner belonged. But to tax it twice; to wring from widow or children or creditors, who have already paid one inheritance tax to the State under whose laws the estate is in course of settlement, another of a like kind, if not unfair, is certainly impolitic. It contravenes the settled conceptions of private international law—conceptions that, through long ages of unbroken tradition, have worked their way into the popular mind, and become identified with those of social justice and economic law.

"Ein tiefer Sinn wohnt in den alten Bräuchen.
Mann muss sie ehren."

According to these, the succession to a dead man's goods is to be determined by the law either of the country of which he was a citizen or of that—generally the same—in which he had his home, and through that law it is to be worked out to the last detail.

As death comes but once to every man and is the one event on the happening of which the devolution of his estate takes place, so that devolution, to work justice, must, as far at least as his personal property may be concerned, follow one single course of law.

During the last few years the principal nations of continental Europe have held four successive Conferences at the Hague, to regulate the rights of the citizens of each with respect to acts and transactions that may come under consideration in the courts of the rest. On several points they have reached a definite agreement, in the shape of reciprocal conventions, ratified by the leading powers. A new convention was proposed by the last Conference, held in June, 1904, on the subject of succession to the dead. It secures its regulation according to the law of the country of which the former owner was a citizen or subject.

England and the United States have thus far adhered to the view that the law of the land in which he had his home should govern. But under either rule the same end is secured—unity of administration. A single succession is to be regulated by a single law.

Our new American practice must operate as a divisive force within the American Union.

It attacks the prosperity of the country at a vital point. The United States have grown great and rich because of the principle of absolute free trade between the States so far as anything in the nature of a tariff is concerned, and absolute free trade in all respects, except so far as Congress may see fit to legislate to the contrary. It was the change to this policy from that of the pre-constitutional era that made the United States a living nationality. Under the Articles of Confederation each of the thirteen equal sovereigns could tax and often did tax the products of the others. In May, 1784,* for instance, Connecticut laid a duty on all goods imported from any other State, except such as had been previously imported from abroad by a citizen of Connecticut for use or sale in Connecticut. This law was expressly made applicable even to the baggage of passengers arriving by water. To such legislation the Constitution of the United States opposed an effective bar, and in so doing benefited every State to the injury of none.

A recent statement from the Bureau of Statistics at Washington shows that the total value of the goods dealt in last year throughout the United States in their internal trade, based on

* Statutes, Ed. 1784, 271.

what they cost the first consumer, was twenty-two billion dollars. This is nearly fifteen times as great as that of the goods which we export; nearly twice that of all the goods imported during the same year in international trade throughout the world, and more than twice that of the whole world's exports for the same period. Much of this home trade is purely domestic; but much also is trade between the States.

Anything which impedes the free transmission of money or moneyed securities from one State to another so far unstrings the sinews of this commerce between the States. To tax their transmission when they pass in a mass, by the event of the owner's death, is to create an impediment to their transmission by him during his life which the public are fast learning to regard as very serious.

This evil first arose during the closing years of the nineteenth century. How shall it be remedied in the twentieth?

Could Congress treat it as so far affecting commerce between the States (and with foreign nations, for the double burden falls often on foreign heirs or legatees) as to justify a statute of the United States providing that such a tax, as regards any one estate or any one item of property belonging to an estate, could be laid but once?

If so, it would be to advance the powers of the nation a step farther than they have ever yet gone, and weaken correspondingly the sovereignty of the States. If, on the other hand, Congress has no such power, does it not naturally lead to the conclusion that the States have? Certainly a remedy more in accordance with our constitutional traditions than an Act of Congress would be concerted action to the same end by the States under the principle of reciprocity.

From the beginnings of American history, neighboring English colonies were accustomed, at times, to send delegates to mutual conferences on matters of common interest. When they became States, the same practice was continued. Agreements were made in such conventions while the Articles of Confederation were in force, affecting matters of importance, although some of the statesmen of the day viewed them with

disfavor as contrary to the spirit of the confederated government and tending to disintegrate the Union.*

This led to the provision in the Constitution of the United States (Art. I, Sec. 10) that no State should "enter into any Treaty Alliance or Confederation" nor . . . "without the consent of Congress . . . enter into any Agreement or Compact with another State or with a foreign Power."

The courts have construed these provisions so as to make them detract as little as may be from the sovereignty of the States.

Three principles may be considered as settled with regard to them:

1. They do not refer to any agreements not affecting the political relations of a State to another State or to the United States.† It was their object to prevent the formation of any combination of States that might encroach upon the supremacy of the United States.‡

2. No agreement or compact between States is to be deemed of that nature, unless it is clearly such.§

3. Agreements or compacts between States of a political nature, although made without asking or obtaining the consent of Congress, are not invalid if Congress afterwards should ratify them.‖

In practice the States from the first have regarded this section of the Constitution as not precluding arrangements and agreements between any of them of a business character, which they might deem of mutual advantage.

They have by concurrent grants of charters similar in form created interstate corporations, which are as much at home in one State as another, and have in each the same powers and rights under the same name and with the same members.¶

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* Madison's Introduction to his Journal of the Federal Convention (Scott's Ed.), 47.

† Virginia *v.* Tennessee, 148 U. S. Reports, 503, 519.

‡ Williams *v.* Bruffy, 96 U. S. Reports, 176.

§ Baltimore & Ohio R. R. Co. *v.* Harris, 12 Wallace's Reports, 65, 82.

‖ Green *v.* Biddle, 8 Wheaton's Reports, 1. Cf. 21 U. S. Statutes at Large, 351; Wharton *v.* Wise, 153 U. S. Reports, 155.

¶ Two Centuries' Growth of American Law, 279; Graham *v.* Boston, Hartford & Erie R. R. Co., 118 U. S. Reports, 169, 170; Report of the American Historical Association for 1902, I, 268.

Interstate Commissions have been constituted by appointments made by neighboring States to ascertain and mark the boundary between them.*

Statutes to promote freedom of intercourse and exchange of business between States, have been passed by one State in favor of non-residents, conditioned on the existence of like legislation in the State of which they may be citizens.

Since the introduction of automobiles statutes have been passed in some States requiring them to be registered and numbered, and the number, with the first letter of the name of the State, to be displayed on the vehicle, but with a provision that this shall not apply to automobiles coming into the State from another in which they had been registered and numbered under a similar law, and which make a similar display of the letter and number required there.†

Foreign insurance companies are often prohibited by statute from entering a State to do business, unless they fulfill certain prerequisites, with an exception in favor of those coming from a State or country where no such conditions are exacted from companies of the State enacting such statute.‡ So they are often subjected to certain taxes or fees, if and only so long as such taxes or fees are required by the State of their charter from companies created by the State by which the statute is passed.§

Reciprocity with reference to foreign countries is also a feature of some of our State statutes for the removal of the common law disability to hold real estate. It is removed as respects citizens of countries imposing no such disability on American citizens who may seek to acquire lands within their jurisdiction.‖

Statutes have been passed by one State to promote the administration of justice in certain others, or in all others, on conditions of reciprocal legislation on their part.

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* Papers of the New Haven Colony Historical Society, III, 284, 286.

† Public Acts of Connecticut, 1903, 73.

‡ See General Statutes of Connecticut, §§3508, 3544, 3652.

§ Public Statutes of Rhode Island, Rev. of 1882, p. 396, Sec. 396; New York Revised Statutes, 9th Ed., II, 1146.

‖ See Texas Civil Statutes, I, Art. 9 (a statute passed in 1854).

Thus in the first half of the nineteenth century New Hampshire enacted a statute to the effect that if one of her inhabitants were wanted in any other State as a witness for the prosecution in a case of felony, a subpœna requiring him to repair thither to testify at the trial might issue from a New Hampshire court on the request of the judicial authorities of the other State. Proper compensation for the expenses of the journey was to be tendered, and if, after such tender to the person whose presence was desired, he failed to appear at the trial, he was to be liable to a forfeiture of $300. Maine then adopted a similar statute except that it applied only to prosecutions pending in a New England State. Massachusetts followed in the same line, except that she confined the remedy to neighboring States, and to Maine, and in 1902 New York did the same with respect to bordering States, but on condition of the enactment on their part of reciprocal legislation of similar effect. Connecticut and Pennsylvania have since passed laws on this subject of the same general purport.*

In some similar way the States of the United States may yet come to a mutual understanding, and reciprocal justice become the rule in dealing with successions, whether by will or by inheritance.

A suggestion to that end was made in 1901 by the Buffalo Conference on Taxation. This body, composed of representatives of about thirty States, appointed by their respective Governors, unanimously adopted this resolution:

"Whereas, modern industry has overstepped the bounds of any one State, and commercial interests are no longer confined to merely local interests; and whereas, the problem of just taxation cannot be solved without considering the mutual relations of contiguous States; be it

"*Resolved*, That this Conference recommend to the States the recognition and enforcement of the principles of interstate comity in taxation. These principles require that the same property should not be taxed at the same time by two State

* Public Statutes of New Hampshire, Ed. 1842, p. 382; of Maine, Ed. 1871, p. 876; of Mass., Ed. 1882, p. 986. Public Acts of Connecticut, 1903, 57; General Laws of N. Y., 1902, p. 328.

jurisdictions, and to this end that if the title deeds or other paper evidences of the ownership of property, or of an interest in property are taxed, they shall be taxed at the *situs* of the property, and not elsewhere. These principles should also be applied to any tax upon the transfer of property in expectation of death, or by will, or under the laws regulating the distribution of property in case of intestacy."*

The Massachusetts Tax Commission in 1897 reported a bill to carry out the same principle, though on somewhat different lines.†

Machinery to facilitate a concert of action for the accomplishment of some such result, has for some years been in existence and active operation. This is the annual Conference of Commissioners of States on Uniform Legislation, held in connection with the meetings of the American Bar Association, and now representing a large majority of all the States. Its office is to frame and recommend to the States for adoption bills for suitable laws on subjects of common concern which ought to be regulated everywhere in the same way. The result of its labors may be seen in the existence of identical laws in the statute books of a number of States, which have been adopted on its initiative, the most conspicuous instance being that of the Negotiable Instruments Act.

It may well be doubted whether the form of reciprocity recommended by the Buffalo Conference is the best. It is not that naturally suggested by the Anglo-American rules of private international law. These would favor adhesion to the law of the State where the succession occurred—that of the last domicil of the deceased owner. On the other hand, the plan so proposed might be more answerable to the demands of modern society. It would serve to pay for protection to property actually received, in contradistinction from protection theoretically imputed.

But the only question to which the limits of an address like this permit me to call your attention is the larger one of the possibility and expediency of any reciprocal arrangements looking in this direction.

* Judson on Taxation, p. 547, note.

† Report of the Commission, p. 191.

Could they or could they not be regarded as varying the public relations of the States concerned? Would or would not each stand towards the other in the attitude of a favored nation, since its citizens would be freed from a burden remaining upon those of other States? Is or is not a statutory grant of an exemption from taxation in favor of those belonging to another sovereignty, conditioned on the concession of a similar privilege by the latter to the citizens of the State enacting the first statute, and followed by such a concession, in substance a political compact between the enacting powers?

If there be any such constitutional bar, it could be easily removed.

The arrangement could hardly be deemed to stand on the footing of a treaty, alliance, or confederation. If not that, the consent of Congress would avoid any possible objection. There is no reason to doubt that this would be gladly given. Congress could hardly fail to welcome any proposition from States, looking towards concurrent legislation of the description named. Not only would it remove what is not unlikely to prove a serious impediment to free commercial intercourse between the States, but it would remove it in the interest of fair dealing and equal rights.

It may be suggested that even with the authority of Congress no such exclusive reciprocity could be established between two States by reason of the further constitutional provision (Art. IV, Sec. 2) that the citizens of each State shall enjoy the privileges and immunities of citizens in the several States.

The purpose of this section, however, is to prevent discrimination by one State against the citizens of another. Can it be said that a statute makes such a discrimination if it leave them entitled to the same privileges and immunities as those possessed by the citizens of the State making the enactment? The citizens of that State being required to pay a succession tax, can the citizens of another State, coming there to receive an inheritance or bequest, complain if they are subjected to the same burden, even if those of a third State may not be?* Is not the discrim-

* Paul *v.* Virginia, 8 Wallace's Reports, 168, 180; Blake *v.* McClung, 172 U. S. Reports, 239, 248, 257.

ination which the Constitution prohibits one in favor of residents against non-residents, rather than one between non-residents who are citizens of different States?

The Supreme Court of the United States in 1831 had before them a cause which showed the complications as to State sovereignty over dead men's estates existing even under the established principles of private international law. A citizen of Virginia died in Pennsylvania, leaving personal property in the District of Columbia. A local administrator was appointed in Washington, and the question was whether the local law there or the law of Virginia should govern the distribution of the Washington assets. The court held that as the District of Columbia had the fund in its power, its law must control its disposition. "Whether," it added in its opinion, "it would or would not be politic to establish a different rule by a convention of the States, under constitutional sanction, is not a question for our consideration. But such an arrangement could only be carried into effect by a reciprocal relinquishment of the right of granting administration to the country of the domicil of the deceased exclusively, and the mutual concession of the right to the administrator so constituted to prosecute suits everywhere in virtue of the power so locally granted him; both of which concessions would most materially interfere with the exercise of sovereign right, as at present generally asserted and exercised."*

The convention here suggested, no doubt, was one to be called by Congress, under Article V of the Constitution of the United States, to propose amendments to it. There had then been but one instance of the convocation of any other kind of convention of representatives of States since 1789. That was the Hartford Convention of 1814, of delegates from three States, and it had been generally and unsparingly denounced as an unconstitutional assemblage for illegal purposes.†

Since that time, however, another of a more imposing character, and equally political in its objects, has been held at Wash-

* Smith, Adm'r, *v.* Union Bank of Georgetown, 5 Peters' Reports, 518, 526.

† Adams, New England Federalism, 245, 256.

ington—the Peace Convention of 1861—in which twenty-one States participated, and which was officially recognized by the President of the United States. The public were satisfied that this body accomplished a useful work in bridging over the passage of power from one party to another at a time when every day of continued peace was of the highest national importance, and although its right to act or indeed to exist was vigorously denied upon the floor by some of its own members,* the verdict of history must be in its favor.

Since then, besides many conferences or conventions from time to time of representatives of States under executive appointment, the National Conference of Commissioners on Uniform Legislation, to which reference has been made, has become a standing institution of unquestioned authority. That authority, indeed, is only to deliberate and to recommend. It makes no agreements between States. But it does initiate action by the States, through which, on some points, they are brought by the legislative action of each into a position of agreement.

Should it be able to agree on the recommendation of a definite, equal, and consistent policy as to the subject which has been under our consideration, expressed in the form of an identical statute for general adoption in each of the States which it represents, it is not impossible that, one after another, the States would fall into line and follow the plan proposed.†

The tendencies of the time make for such a movement. Individualism and State-isolation are each giving way at every point of material contact to Collectivism. The time-spirit and the world-politics of the twentieth century alike point to reciprocal governmental action on a great scale, for the prevention of international or interstate complications and collisions, as the true basis of national prosperity.

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* Debates and Proceedings of the Peace Convention of 1861, 129, 134, 415.

† One State has already made a move in this direction. Connecticut prior to 1903 had not taxed goods of non-resident decedents by means of a succession duty. In 1903 she laid such a tax on them, but with a waiver of its enforcement in case of a succession to decedents belonging to a State or country not exacting such a duty upon personal property left within its jurisdiction by Connecticut decedents. Public Acts of Conn. for 1903, 43, Sec. 2. Gallup's Appeal, 76 Conn. Reports, 627; 57 Atlantic Reporter, 699.

PAPERS READ.

The Working of the Anthracite Coal Strike Agreement. By Wm. H. Taylor.

Present Status of Railroading in China. By C. H. Wang.

Can the South Manufacture Her Own Cotton? By Charles Lee Raper.

Ethnic Factors in Education. By Edgar L. Hewett. Published in American Ethnologist.

The Press as an Educator. By Wm. H. Lynch.

The Ideal Training for Social Service. By Mrs. Anna Garlin Spencer.

Work of the National Child Labor Committee. By Samuel McCune Lindsay.

Child Labor in Southern Mills. By A. K. McKelway.

Some Survivals of Primitive Racial Instincts in American Negroes. By Edward L. Blackshear.

Sociological Factors in the National Irrigation Movement. By Guy E. Mitchell. Published in Forestry and Irrigation.

THE BASIS OF ECONOMICS AS AN EXACT SCIENCE. BY SIMON NEWCOMB.

BEEF PRICES. BY FRED. C. CROXTON. Published in Journal of Political Economy.

THE MOVEMENT OF WOOD PRICES AND THEIR INFLUENCE ON FORESTRY TREATMENT. BY B. E. FERNOW.

THE WHEAT SITUATION IN THE UNITED STATES. BY JOHN CASSEL WILLIAMS. Published in New York Journal of Commerce.

PRESENT STATUS OF MARITIME ENTERPRISE. BY WINTHROP L. MARVIN.

UNCONSIDERED PHASES OF FOREIGN TRADE. BY HAROLD BOLCE. Published in Booklovers' Magazine.

THE PRESENT DEMAND FOR AND THE ECONOMIC USES OF WOOD. BY WILLIAM R. LAZENBY. Published in Proceedings of Ohio State Forestry Society.

ANALOGIES BETWEEN THE EVOLUTION OF INTERNATIONAL AND OF PRIVATE LAW. BY EDWARD LINDSEY.

MARITIME EXPANSION: RISE OF OCEANIC COMMERCE. BY JOHN FRANKLIN CROWELL.

SECTION K.

Physiology and Experimental Medicine.

OFFICERS OF SECTION K.

Vice-President and Chairman of the Section.

H. P. BOWDITCH, Cambridge, Mass.

Secretary.

FREDERIC S. LEE, New York, N. Y.

Member of Council.

R. H. CHITTENDEN.

Sectional Committee.

H. P. BOWDITCH, Vice-President, 1904–'05; FREDERIC S. LEE, Secretary, 1904–05.

J. McK. CATTELL, 1 year; R. H. CHITTENDEN, 2 years; W. T. SEDGWICK, 3 years; FRANK BAKER, 4 years; C. S. MINOT, 5 years.

Member of General Committee.

G. R. STERNBERG.

PAPERS READ.

[No papers were read before Section K at the Philadelphia meeting.]

EXECUTIVE PROCEEDINGS.

EXECUTIVE PROCEEDINGS

REPORT OF THE GENERAL SECRETARY.

The first meeting of the American Association for the Advancement of Science was held in the City of Philadelphia, September 20th, 1848. There were then 461 members of the Association, but we have no record of the number in attendance. The second Philadelphia meeting was held September 3, 1884. The Association then numbered 1981 members and the attendance was 1,261, including 303 members of the British Association for the Advancement of Science and nine other foreign guests. The third Philadelphia meeting was held December 27th to 31st, 1904. The total membership was nearly 4000 and the registered attendance numbered 588 members and 104 members of Affiliated Societies, making a total registered attendance of 692 members. From 200 to 400 did not register, so that we may safely conclude that the total attendance was at least 890, and perhaps very much larger. The last meeting was, therefore, the third largest in point of numbers since the year 1884. While numbers are not an index of the value of a meeting, they do show the amount of interest taken in its proceedings, and from that standpoint we may conclude that the third Philadelphia meeting was a success. It was also a success from the standpoint of number of papers read and the general interest in the papers, as well as in all of the proceedings of the Association.

Tabulating the members according to the Sections for which they registered, we find the following numbers:—

Section A	57
Section B	66
Section C	75
Section D	16
Section E	79
Section F	104
Section G	103
Section H	44
Section I	14
Section K	25

Giving a total of 581 who signified their preference as to Sections.

These figures show that where a national scientific society met in conjunction with the Association, the corresponding section was large and where a national scientific society did not meet, the attendance was very small. This would seem to indicate that members of the Association prefer to attend a meeting of the National Society rather than the meetings of the Association unless the two meet together.

The University of Pennsylvania placed its halls and laboratories freely at the disposal of the Association and each day furnished a lunch to the members. The Association has never received more careful attention than it received at this meeting. A vote of thanks was extended to the University, the details of which will be found later on in the report.

In former years a daily program has been published, showing the papers to be read that day and giving a list of the members in attendance. This has always been a severe drain upon the resources of the Association and it was decided this year to use but one program, which was distributed to members on the first day that papers were read. This single program seemed to answer its purpose as well as the daily programs have in the past, except that many members missed the lists of those in attendance. If some method can be devised by which members may know who are present, there can be no objection to the single program.

Since the last meeting of the Association 377 members have been elected; although this is not as large as the number elected in previous years, yet it shows a steady growth and a growing interest on the part of the public in the work of the Association.

There has always been great difficulty in getting reports of the Association and its work published in the daily papers, except those in the city where the meeting is held. This year the Committee on Policy of the Association instructed the permanent secretary to appoint a press secretary. The permanent secretary appointed Mr. Theodore Waters. Reports of the meetings were prepared each day and sent to most of the prominent newspapers of the country. It was impossible to make the reports as full as desired, as some of the members of the Association who read papers did not give their abstracts to the press secretary, although they were requested to do so. If the readers of papers will take pains to see that their abstracts are in the hands of the press secretary, entirely satisfactory reports can be sent out in future. It is greatly to be desired that the press of the country give some attention to the meetings of our greatest scientific society.

The two questions of general interest were the time of meetings of the Association and our relation to the affiliated societies. These questions have been actively discussed before, but they do not seem to be definitely settled in the minds of many. The Sections which have been in the habit of giving many excursions and who study objects out of doors, prefer a summer meeting, but it seems that a large majority of the Association is in favor of the winter meetings, as the general committee unanimously decided to hold the next meeting during the winter. The Committee on Policy reported that it had considered this matter and would recommend that this general committee request the next general committee to hold a summer meeting in Ithaca during the summer of 1906. The success of this meeting will undoubtedly have a great deal to do with settling the question of summer meetings.

There seems to be no objections on the part of the Association to holding two meetings each year, one during the winter and one during the summer. The expense involved would be considerable, but the Association can bear it and perhaps the best solution of the problem will be two meetings. This is a question which the future must decide.

AFFILIATED SOCIETIES.

The following affiliated Societies held sessions in conjunction with the Association.

American Alpine Club.
The American Anthropological Association.
The American Chemical Society.
The American Folk-Lore Society.
The American Geographers' Association.
The American Mycological Society.
The American Philosophical Association.
The American Physical Society.
The American Psychological Association.
The American Psychological Society.
The American Society of Naturalists.
American Society of Vertebrate Paleontologists.
Association of American Anatomists.
The Association of Economic Entomologists.
The Astronomical and Astrophysical Society of America.
The Botanical Club of the Association.
The Botanical Society of America.
The Society for Plant Morphology and Physiology.
The Society for the Promotion of Agricultural Science.
Sullivant Moss Chapter.
The Wild Flower Preservation Society of America.
The Entomological Club of the Association.
Eastern Branch of American Society of Zoologists.
The Fern Chapter.
The Geological Society of America.
The Sigma Xi Honorary Scientific Society.
The Society of American Bacteriologists.
The Society for Horticultural Science.
The Southern Society for Philosophy and Psychology.
The Pelee Club.

The Association is still pursuing the policy of encouraging the great national societies to meet at the same time and place with it. The Association secures rooms, provides accomodations, makes arrangements with hotels and railways and in all points takes charge of general arrangements without expense and without trouble to the affiliated societies.

Nearly, if not all, of the societies meet in perfect harmony with the respective sessions. In almost every case the sections have charge of the meetings during one half of the day and the affiliated societies have charge of the meetings during the other half of the day. Thus there is no friction and papers are presented before both bodies, while there is the additional advantage of a larger attendance at both the section and the Society. It is hoped that this arrangement will appeal in a greater degree to the national societies until all of them enter into this arrangement with the Association. The attendance of the members of the Societies this year indicates that they are willing to cordially co-operate with the Association and turn out in large numbers to attend these joint meetings. There is nothing in the arrangement which prevents an affiliated society holding a separate meeting at any other time of the year if it chooses.

The first session of the Fifty-fourth meeting of the American Association for the Advancement of Science was called to order in College Hall Chapel, University of Pennsylvania, Philadelphia, Pa., at 10 A. M., Wednesday, December 28th, 1904, by the retiring President, Dr. Carroll D. Wright. Dr. Wright introduced the President-elect, Dr. William G. Farlow.

Dr. FARLOW: Ladies and Gentlemen: Allow me to thank you most heartily for the cordial welcome which you have extended to the members of the American Association for the Advancement of Science.

The hospitality of Philadelphia is a matter of tradition, and especially might a scientific society count on a warm welcome in a city which is the home of the oldest scientific society in the United States, a city rich in memories of Franklin, Rittenhouse and Bartram.

It is now twenty years since the Association last met in Philadelphia, and those of us who were then present, while glad that our welcome is as warm as ever, can hardly regret that the city itself is some 80 degrees less warm than it was then, and we feel that we shall be less of a burden to our hosts at this season of the year. To many of us the present occasion offers a desired opportunity of seeing for the first time the great advance made in recent years in the equipment of your universitv and other scientific institutions, whose walls have been placed so liberally at our service, Certainly no city could offer us more commodious and easily accessible places of meeting. But what brings us here to-day is not so much our desire to see your halls and laboratories as the opportunity of making the acquaintance of your scientific men at home, and of seeing the work which they are doing, which gives these halls and laboratories their real value.

With your older men we are already acquainted, but the great advantage of meetings like the present is that they bring us into close contact with the younger men, some of whom we see for the first time; men with a future who meet here men with a past. Would that one might have with us today two who welcomed the Association in 1884; but since that Leidy and Cope have passed away, and, although we seek in vain their once familiar faces, we shall find the spirit which they have impressed on the scientific

work of your University. Although their death has left gaps which cannot at once be filled, the field of science is constantly broadening, and you now have among your scientific men many who are treading new paths and exploring new fields quite unknown twenty years ago.

In the past the mission of our Association has been, by bringing together in different parts of the country those best known for their scientific work, to encourage and strengthen the national scientific spirit, and it must be placed to the credit of the Association if this missionary work has no longer the same importance which it formerly had.

If the Association is able to act as a bond of union between the different special societies formed to meet the demands of the growth of science in recent years, and, without hindering specialization, to preserve the tradition of the interdependence of the different branches of science, it still has a mission of importance to fulfill.

Dr. Farlow then presented Provost Harrison, of the University.

Provost HARRISON: The local committee, to which has been confided the pleasant part of arranging for your entertainment while here, has asked me to express its welcome upon this occasion of the Fifty-fourth meeting of the American Association for the Advancementof Science, here in Philadelphia, and here at the University of Pennsylvania.

We do not at all forget that the first meeting of the Association was held in this City, in 1848, with a membership of less than 500 and without record of the number in actual attendance. We know, too, that the Association met here once again, in 1884. We like to link these meetings—the two which have gone before and that of this occasion—with many names of scientific observers no longer here, who lived in this city, which we wish to make homelike to all of you during these few days of the closing year, and as often in the future as we may have the good fortune to bid you welcome, whether you come in groups as societies or again in such a union of the American Association, or, indeed, whensoever any one of you may wish to return.

We are glad to link the names of those who are no longer here, but who lived in this city. This State and town was the refuge of Priestly, and the home of Franklin and Rittenhouse and Rush; the city of Cope and of Hare, of Leidy and Bache and Bartram, of Wistar and Brinton and John Ryder—never to be forgotten; the place, too, of many others no longer present, but whose names are cut in equal letters upon the tablets in your Westminster Abbey. I will not name any living members of the Association.

The progress of the sciences or of knowledage gained by external observation is marked by the extraordinary progress in the membership of your own body.

It seems to me to be a just cause of congratulation that representatives of so many learned, scientific societies can assemble together without fear of jealousy or rivalry, but simply as American scholars, each willing and anxious to add his contribution to the store of human knowledge. I think that the mere fact that it is possible for so many men—probably with great dif-

ferences or opinion—to meet together upon the common ground of scholarship is a matter of which we in America may well be proud.

And this ability to meet in this way is of rather recent possibility. Everyone has read the address of Lord Salisbury before the British Association delivered at Oxford in 1894, when he referred to the encounters which took place a generation earlier, at that venerable university, and said that so much energy was on that occasion converted into heat as to have kept scientific men away from Oxford for thirty-four years.

The change is a wonderful change and is not to be overlooked. It is a conquest of reconciliation. Science draws together because unselfish and reasonable. It muust be consistent, and therefore experience shows that only the meetings of educated men are attended with progressive and harmonious results.

The other consideration as to which I think that this meeting is a subject of congratulation, is connected with your broad title, The American Association. Civilization is association, and this form of association is one of the highest forms of civilization. It is true that we may not all agree. Truth is not so easily uncovered, is not disclosed to all, and there may be those who prefer to have truth on their side, rather than to be on the side of truth; but, taking it all in all, we may be quite sure, it seems to me, that the purposes of such meetings as this, and their results, are as beneficent to mankind as the congresses at the Hague, or the "Alliances," which are so often announced at the cannon's mouth!

America, North and South, may be brought into accord—can be brought ;nto accord—only through the influence of its educated men, whether those men choose the reflective or the observing sciences. There is a certain influence—the influence of enlightened men—in all classes of American society, which must be looked to to leaven the body politic, and govern both its aspiration and its purposes.

Influence never ascends—it always descends. A few days before his death, Lord Herschel said, in Philadelphia, that the axioms of the philosophers became in time the sayings of the market-place.

It is one of these axioms that no uneducated nation can expect long to compete with educated nations. The absence of any general university culture in France left her, a century ago, at the mercy of visionaries, and from that time until now hardly anything in France has been stable. On the other hand, in England and Germany a noble civilization, arising from the recognition of higher educational necessities is set before us, although in different forms, Germany in science and England in political progress. With us, on this continent, the ceaseless energy of the American people, the wealth of its resources, the productiveness of its industries, are forcing the continent into a position which was never dreamed of, and one which must soon affect the Temperate Zone of South America as well as it has that of North America.

It semes to me then that the civilization and patriotic results—continental in their extent—are true subjects for congratulation and for welcome.

But I do not wish to conclude this message without a final word from the University. I am sure that the trustees and the faculties of the University of Pennsylvania will desire me to thank you that you have selected Philadelphia, and the site of the University, for your many meetings. Those who are students can best enjoy the contact of mind with mind; but all of us, whether students or not, are glad to welcome so many distinguished men. All confidently expect that the papers here read, and the discussions upon them, and the intercourse, will prove of the greatest benefit to the scientific life of the University. So for all these reasons, which I have briefly stated, Mr. President, you may be sure that the welcome extended on behalf of the Local Committee and the University goes out to you most amply, and from a full heart.

President Farlow thanked Provost Harrison for his words of welcome and then asked the General Secretary to make the announcements from the Council.

Mr. Howe (General Secretary): The Council has voted to extend the privileges of associate membership for this meeting to members of the local committee, residents of Philadelphia and vicinity and to members of the affiliated societies.

The following committees have been appointed to serve during this meetings:

Committee on New Members: The Permanent Secretary and the Secretary of the Council.

Committee on Fellows: The General Secretary and the Vice-Presidents of the Sections, Mr. Howe, Chairman.

Committee on Grants: The Treasurer and the Vice-Presidents of the Sections, Mr. R. S. Woodward, Chairman.

It has been decided to hold sessions of the Council at 9 o'clock in the morning, but there will be no other general session until Saturday morning at 10 o'clock.

Dr. Calvert, Secretary of the Local Committee, made some announcements in behalf of that Committee in regard to the arrangements which had been made for the comfort and convenience of the Association.

It was announced that after the adjournment of the General Session, the several sections would be organized in their respective rooms.

In accordance with a suggestion from the Committee on the Policy of the Association, the vice-presidential addresses were scattered throughout the week, instead of being given on the same date. It was thought best to have in addition to a vice-presidential address, one or more papers of general interest, which would follow the address, thus taking up the greater part of that session.

The general program of the week was as follows:

General Events.

The Council of the Association meets daily from December 28 to December 31, inclusive, at 9 A. M., in the auditorium, Houston Hall.

WEDNESDAY, DECEMBER 28, 1904.

Meeting of the Council at 9 A. M. as above.

First general session of the Association at 10 A. M., in the Chapel, College Hall.

The meeting was called to order by the retiring President Dr. Carroll D. Wright, who introduced the President Elect, Dr. W. C. Farlow.

Addresses of welcome were delivered by members of the Local Committee.

President Farlow replied.

Announcements by the General, Permanent and Local Secretaries.

Agreement on the hours of meeting.

Adjournment of the General Session, followed by the organization of the Sections in their respective halls.

1 P. M.

Luncheon to the members of the Association in the Gymnasium.

At 2.30 P. M.

Addresses of Vice-Presidents, as follows:

Vice-President Tittmann, before the Section of Mathematics and Astronomy, in College Hall, Subject, "The Present State of Geodesy."

Vice-President Bancroft, before the Section of Chemistry, in the Harrison Laboratory of Chemistry. Subject, "Future Developments in Physical Chemistry."

Vice-President Russell, before the Section of Geology and Geography, in Geological Laboratory. College Hall, Subject, "Co-operation among American Geographical Societies."

At 8 P. M.

Address by Dr. Carroll D. Wright, the retiring President of the Association, in the Gymnasium. Subject, "Science and Economics."

At 9 P. M.

Reception by the Provost of the University of Pennsylvania, Dr. C. C. Harrison, and Mrs. Harrison, in the Museum.

THURSDAY, DECEMBER 29, 1904.

Meeting of the Council at 9 A. M.

Meetings of the Sections at 10 A. M.

At 1 P. M.

Luncheon to the members of the Association in the Gymnasium.

At 2.30 P. M.

Addresses of Vice-Presidents as follows:

Vice-President Hall, before the Section of Physics, in Morgan Laboratory of Physics. Subject, "A Tentative Theory of Thermo-Electric Actions."

Vice-President Macbride, before the Section of Botany, in Biological Hall. Subject, "The Alamogordo Desert."

Vice-President Mark, before the Section of Zoology, in Laboratory of Physiology and Pathology. Subject, "The Bermuda Islands and the Bermuda Biological Station for Research."

Vice-President Baldwin, before the Section of Social and Economic Science, in Logan Hall. Subject, "The Modern Droit d'Aubaine."

At 8 P. M.

The retiring President of the American Chemical Society, Dr. Arthur A. Noyes, delivered a lecture, illustrated by experiments, on the "Preparation and Properties of Colloidal Solutions," in the Harrison Laboratory of Chemistry.

FRIDAY, DECEMBER 30, 1904.

Meetings of the Council at 9 A. M.

Meetings of the Sections at 10 A. M.

At 1 P. M.

Luncheon to the members of the Association in the Gymnasium.

At 2.30 P. M.

Addresses of Vice-Presidents as follows:

Vice-President Woodward, before the Section of Mechanical Science and Engineering, in the Mechanical Laboratory. Subject, "Recent Progress in Engineering Education."

Vice-President Saville, before the Section of Anthropology, in the Museum of Science and Art. Subject, "Mexican and Central American Archæology."

At 10 P. M.

Meeting of the General Committee at the Hotel Walton.

SATURDAY, DECEMBER 31, 1904.

Meeting of the Council at 9 A. M.

Final General Session at 10 A. M., in the Chapel, College Hall.

Meeting of the Sections following the adjournment of the General Session.

EXCURSIONS.

Excursions to the following plants were arranged by the Local Committee:

Belmont Filtration Plant (Filtration of City Water).

F. A. Poth & Sons' Brewery.

J. P. Baltz Brewing Company.

Eddystone Print Works, Eddystone, Pa. (Bleaching and dyeing of all kinds of cotton goods, engraving and preparing the rolls).

Barrett Manufacturing Co. (Refined coal-tar chemicals).

Baldwin Locomotive Works.

Atlantic Refining Co. (petroleum oils).

Cramp's Ship-yard.

Camden Coke Company (Otto-Hoffman by-product coke ovens).

United Gas Improvement Co. (coal and water gas).
Hulton Brothers (dyeing and finishing).
Forth & Foster (dyeing and finishing).
United States Arsenal.
United States Mint.
United States Navy Yard.
Gillinder's Glass Works.

High Pressure Fire Service Plant, Kindness of Mr. F. L. Hand, Chief of the Bureau of Water, Philadelphia.

Philadelphia Electric Co.'s New Power Station, through the kindness of Mr. J. B. McCall, President Phila. Electric Co.

Philadelphia Subway—through the kindness of Mr. W. S. Twining, Chief Engineer, and Mr. Charles M. Mills, Principal Assistant Engineer Subway, and Elevated Railway Construction.

Wm. Sellers & Co., Inc.—through the kindness of Mr. William Sellers and Mr. Coleman Sellers, Jr.

On Monday evening, December 26, 1904, the American Physiological Society held a smoker at the University Club.

On Tuesday evening, December 27, 1904, Prof. W. F. Osborn gave a lecture before the American Society of Naturalists in the Academy of Natural Sciences on the subject: "Recent Discoveries of Extinct Animals in the Rocky Mountain Region and their Bearings on the Present Problems of Evolution."

On the same evening the American Society of Naturalists and the affiliated societies gave a smoker at the University Club.

Wednesday afternoon, December 28, 1904, was held the annual discussion of the American Society of Naturalists on the question: " Mutation Theory of Organic Evolution." This was participated in by Dr. D. C. MacDougal, Prof. W. E. Castle, Prof E. Conklin, Prof. W. B. Scott, Prof. F. Dwight, Prof. L. H. Bailey and Dr. W. M. Wheeler.

Wednesday evening, December 28, 1904, the annual dinner of the American Society of Naturalists was held, after which the presidential address was read by Prof. E. L. Mark.

On Thursday evening, December 29, the American Chemical held a Commers at the University Club.

The same evening the Psychological and Philosophical Associations held a smoker.

The same evening the Society of the Sigma Xi held a convention in College Hall.

Friday evening December 30, the American Alpine Club beld its annual dinner at the University Club.

The Council elected as members of the Council at Large, J. M. Cattell, J. M. Coulter and H. F. Osborn.

Prof. C. R. Barnes, of the University of Chicago, Dr. H. C. Cowles, of the University of Chicago, and Mr. C. L. Shear, of the U. S. Department of Agriculture, were appointed as representatives to the International Botanical Congress to be held in Vienna in 1905.

Dr. W. H. Hale introduced the following resolution, which was adopted.

"*Resolved*, That the American Association for the Advancement of Science hereby extends its hearty congratulations and best wishes to Dr. Martin H. Boyé, a founder of this Association, and the only surviving founder of the parent association, that of American Geologists, afterwards called the American Association of Geologists and Naturalists, which was founded in this city in 1840, Dr. Boyé being present at that time, as well as at the founding of the A. A. A. S. in 1848."

REPORTS OF COMMITTEES.

The following reports of committees were presented to the Council. They were accepted and ordered printed:

ON THE INTERNATIONAL CONGRESS OF AMERICANISTS.

The International Congress of Americanists held its fourteenth biennial meeting in Stuttgart, Germany, August 18–23, 1904. On June 1, 1904, I received a communication from you announcing my appointment as the representative of the American Association for the Advancement of Science at this meeting. The designation was gladly accepted, as it had already been arranged that I should attend the Congress on behalf of the Smithsonian Institution.

I now have the honor to report that the meeting was in every way a most gratifying success and that the representation of the American Association was duly recognized and published in the official bulletins of the Congress. The attendance was largely German, but representatives from a dozen other countries were present and took an active part in the proceedings. The papers presented related almost exclusively to American history and anthropology, and especially to South American subjects. The Germans as well as the French have given very great attention to investigations on that continent.

The next meeting of the Congress is to be held at Quebec in August, 1906.

Very respectfully,

W. H. HOLMES.

ON ANTHROPOMETRY.

The committee begs to report that individually and as a committee they have been carrying on anthropometric work during the past year. It was not feasible to arrange an anthropometric laboratory last year at St. Louis, but this year excellent arrangements have been made in connection with the psychological laboratory of the University of Pennsylvania. Measurements of the members of the Association are being made by Messrs. V. A. C. Henmon, F. Bruner, and G. C. Fracker, with the co-operation of Professor Thorndike, Dr. Woodworth, and members of the committee. The chairman of the committee is making an extended study of American men of

science; two papers have been published on the subject and there is now in press a Biographical Directory of American Men of Science, containing much material that can be used. We may call special attention to the Anthropometric and Psychometric Laboratory of the Louisiana Purchase Exposition, arranged by Dr. McGee, head of the department of Anthropology. The Laboratory, under the direction of Dr. Woodworth, assisted by Mr. Brunner, made measurements of about 1,000 representatives of different races, especial attention being paid to the native races of the Philippine Islands.

We ask that the committee be continued and that an appropriation of fifty dollars be made for the expenses of an anthropometric laboratory at the next meeting of the Association.

J. McKEEN CATTELL,
Chairman.

ON THE ATOMIC WEIGHT OF THORIUM.

The work on the Complexity of Thorium by Chas. Baskerville and R. O. E. Davis, referred to in our last report, has been repeated, verified and extended by Fritz Zerban. The investigation was prosecuted partly in the Laboratory of the University of North Carolina and is continuing in the College of the City of New York. Larger amounts of the pure thorium compounds have been fractioned. Baskerville and Zerban are at present busied with removing entirely from the new thorium the contaminating constituents preliminary to a determination of its physical constants. Coincident with this work they are studying the properties of the novel impurities, which have been designated "Carolinium" and "Berzelium." The research is being aided by the Carnegie Institution.

Concerning the second problem assigned your committee for supervision, namely, the work on præseodymium, it would make the following report: Baskerville and G. MacNider did not succeed in proving the complexity of that constitutent of the old didymium. The methods of attack were (1) production of higher oxided by fusion with sodium dioxide; (2) fractional solution of the well-known black oxide in hydrochloric acid at variable temperatures; and (3) fractional precipitation of oxidate at different temperatures zero, 20° and 100° C. A Zeiss comparison spectrometer, purchased by a grant from the Council, was used for controlling the progress of the work, which will be continued.

We therefore beg leave to report progress.

Respectfully submitted.

CHAS. BASKERVILLE,
JAS. LEWIS HOWE,
F. P. VENABLE.

ON THE STUDY OF BLIND INVERTEBRATES.

Owing to the absence of the secretary of your committee in the caves of Cuba during the last meeting of the Association, a report on progress was omitted at the St. Louis meeting.

Since the last report the following papers based in part at least on material collected with the grant of three years ago have been published:

1. Report on the fresh water fishes of western Cuba. Bull. U. S. Fish Comm., for 1902, 211–136.
2. The water supply of Havana, Cuba. Science N. S. XVII, 281–282.
3. The eyes of Typhlops lumbricalis, a blind snake from Cuba. Biol. Bull. V., 261–270, by Mrs. E. F. Muhee.
4. The ovarian structures of the viviparous blind fishes Lucifuga and Stygicola. Biol. Bull. VI, 33–54. H. H. Lane.
5. The history of the eye of Amblyopsis from the beginning of its development to its disintegration in old age. Mark Anniversary Volume, 167–204.
6. Divergence and convergence in fishes. Biol. Bull.

Number five is the most important of these and gives a complete account of the eyes of the largest of our blind fishes. Further work on this form should consist in noting the changes of the eyes in individuals reared in the light.

Several papers are in preparation.

Several years ago a Mr. Donaldson died in Scotland, owner of a farm of somewhat over 182 acres of land near Mitchell, Indiana. He was apparently without legal heirs. Suit was brought by the State of Indiana to have this farm escheat to the state. The suit was contested by Scottish heirs of Mr. Donaldson, but was won by the state. This farm is in the midst of the cave region of the Ohio Valley to which belong Wyandotte and Mammoth caves and is much more ideally adapted for experimental work with cave animals than either of the larger caves. On it are easily accessible some very large rooms provided with water. On it are the only entraces to an underground stream which I have followed over a mile by actual measurement and from which all of my material of Amblyopsis was obtained. Finally on it the stream comes to the surface under conditions that make the farm admirably adapted for surface ponds and pools to rear cave animals in the light.

The American Association at its Washington meeting passed resolutions asking theState of Indiana to set this aside for a State Reservation and part of it for an experimental farm for the investigation of cave animals, etc. In the winter of 1902, the State Legislature passed a bill in part as follows:

The title of all such lands shall be and remain in the State of Indiana and such lands shall be devoted to educational purposes.

The control and management of all such lands shall be vested in the Trustees of Indiana University, and such lands may be used by said Trustees for any proper educational purposes.

Said board of trustees may, in its discretion, set off any portion of such grounds to the use of the State Board of Forestry or to that of Purdue University, or any other educational or scientific institution of the State. In the meanwhile the heirs appealed the suit to the Supreme Court of Indiana, which also ruled in favor of the State in August of 1903. The heirs thereupon asked the same Supreme Court to grant them a new hearing before itself and there the matter has been suspended for over a year. It seems very probable that this farm will ultimately pass into the possession of the Indiana University and can then be used for experimental work with cave animals.

I have personally received a grant from the Carnegie Institution which enabled me to make further attempts to secure the embryological material of the Cuban blind fishes without, however, being entirely successful in securing this much desired series of embryos.

The most notable and systematic piece of cave work so far undertaken is in preparation by my assistant, Mr. A. M. Banta. He is making a physical and biological survey of Mayfield's cave, situated but five miles from my laboratory. He has determined the distribution of animals in the cave, the per cents. of the total cave fauna that is accidental, occasional or permanent. He is working in the interrelation of these forms and determining the modifications of the permanent members of the fauna to adapt them to cave life. This piece of work will form a base line for future work with the fauna of caves and it is very desirable that Mr. Banta be enabled to make similar studies of a few selected caves in the various cave regions of America.

It is recommended that the committee be continued and that an appropriation of $100.00 be made to continue the work of the committee.

Respectfully submitted for the committee,

E. H. EIGENMANN, *Secretary.*
THEO. GILL,
S. K. GAGE.

ON INDEXING CHEMICAL LITERATURE.

The committee on indexing chemical literature, appointed by your body at the Montreal Meeting in 1882, respectfully presents to the Chemical Section its twenty-second annual report, covering the eighteen months ending December 1, 1904.

WORKS PUBLISHED.

A Select Bibliography of Chemistry, 1492–1902. By Henry Carrington Bolton. Second supplement. Smithsonian Miscellaneous Collections, No. 1440. City of Washington, 1904.

This supplement brings down the literature of chemistry from the close of the year 1897 to the close of the year 1902. The author died while the publication was in press and most of the proofreading, as well as the preparation of the index, was done by Mr. Axel Moth of the New York Public Library.

In the Arbeteien aus dem Kaiserlichen Gesundbreitsamt, volume 21, pages 141 to 155 appears a critical bibliography of sulfur dioxid in wine, by W. Kerp.

Indexes on the literature of gallium and of germanium by Dr. Philip E. Browing of New Haven, Conn., have been completed and accepted by the Smithsonian Institution for publication.

An index to the literature of radium and radio-activity has been completed by Dr. Chas. Baskerville and Mr. Geo. F. Kunz and is expected to appear in a bulletin of the United States Geological Survey, as an appendix to a paper by Mr. Kunz on radium.

An index to the literature of solubilities, 1875–1903, by Mr. Atherton Seidell of the Bureau of Soils, is now in the hands of the committee.

The index to the literature of glucinum, by Prof. Chas. E. Parsons, of New Hampshire College, Durham, New Hampshire, has been completed.

As is well known, for a number of years such bibliographies as have been recommended by their committee have been accepted by the Smithsonian Institution for publication in its Miscellaneous Collections. It has thus been possible to put into the hands of specialists and others, valuable indexes which could not otherwise be rendered accessible.

That it is not deemed possible for the Smithsonian Institution to continue this work, appears from the following extracts from correspondence with Mr. S. P. Langley, Secretary of the Institution.

"The institution has found it necessary to discontinue for the present the publication of separate indices to the literature of the various chemical elements."

The resources of the Smithsonian Institution, as is well known, are limited, and must be distributed over a very considerable variety of interests. When, failing Congressional aid, it seemed that the project of the International Catalogue of Scientific Literature could not proceed without the establishment of an American regional bureau I decided to assure this on the part of the Smithsonian Institution, as the allotment made for this purpose is practically all that can be spared for any current indexing work.

The various bibliographies to chemical elements and other chemical indexes could not apparently have been projected upon a plan that would fall in with this catalogue, since at the time they were begun no one had the catalogue in mind. Accordingly, I find that the earlier ones come down to 1887, 1893, 1896, and 1900, and a more recent one, Thorium, down to 1902. This brings up the entire question of retrospective indexing and bibliography previous to the date 1901, designed to cover the period prior to the beginning of the International Catalogue.

Such a project for all science should of course only be taken up after mature deliberation, and could only be carried through by International cooperation. Meanwhile, it seems prudent for the Institution to await a careful consideration on the part of all interested in the whole subject, chemistry being, of course, but one of the large group of sciences whose workers must be considered. In view of these considerations the importance of which you will, I am sure, recognize, I am constrained to leave the entire matter in abeyance for the present.

In view of the above, it may be questionable whether the work of this committee has not been completed as far as it is possible to carry out the offices for which it was originally constituted. It may, however, be wise to continue it for another year, to await developments.

In conclusion, references should be made to the great loss sustained by the committee, the Section and the Association, in the death on November 19, 1903, of Dr. Henry Carrington Bolton, who from the first appointment of this committee has been its chairman. The work of Dr. Bolton in the field of chemical and alchemical bibliography needs no encomium; it is invaluable to all workers in these fields.

JAS. LEWIS HOWE, *Chairman.*
F. W. CLARK,
H. W. WILEY.

ON ELECTROCHEMISTRY.

A pure iridium electrode was purchased and some rhodium powder. It was deemed advisable to precede the electrochemical portion of the investigation by a study of the chemical phenomena caused by these metals when no current passed. With this in view experiments have been made on the action of these metals on formic acid. These have confirmed the qualitive results of Deville and Debray that the decomposition products are essentially carbon dioxid and hydrogen under these circumstances and not carbon nonoxide and water. The reaction starts at a higher temperature than one would have supposed from the statement of Deville and Debray as to "gentle heating." The rate of decomposition of liquid formic acid is constant when the decomposition products are allowed to pass off, but there is need of the further study of the behavior of the acid in a closed space. This will be taken up next and after that the electrolysis. The effect of the iridium on the chemical and electrochemical equilibrium between chlorine and water will also be studied. For this work your committee asks for a grant of an additional sixty dollars.

The committee begs leave to report progress.

Respectfully.

WILDER D. BANCROFT,
EDGAR F. SMITH.

On Grants.

The committee on grants recommended that the following grants be made for the year 1905:

To the committee on Anthropometry	$50.00
" " Electrochemistry	60.00
" " Cave Fauna	100.00
To the Concilium Bibliographicum	100.00
To W. H. Dall to assist in republishing a rare work on Mollusks, the amount to be repaid in the printed volume	50.00

L. O. Howard,
Chairman.

On the Walter Reed Memorial.

At a meeting of the Association held in Washington, a committee was appointed of which I was made chairman, to take such measures as might be found wise for securing a permanent memorial of Major Walter Reed, U. S. A., in recognition of his important services to humanity. Acting under this authority, it was at length found expedient, after several preliminary meetings, to form an incorporation in the City of Washington to hold such funds as might be contributed. This incorporation is now endeavoring to raise the sum of $25,000, of which the income may be paid to Mrs. Reed and the principal may be devoted to a permanent memorial of Dr. Reed. More than $13,000 are subscribed already, a large part of this amount coming from the medical profession. This is all in addition to the action of Congress, which has given, on the representations of your committee, an unusual pension to Mrs. Reed.

The effort is now making to secure the additional sum of $12,000 and the co-operation of all members of the American Association for the Advancement of Science in urgently desired.

Yours respectfully,

Daniel E. Gilman,
Chairman.

On the Relations of the Association to the Journal Science.

We beg to report that the arrangement by which Science publishes the official notices and proceedings of the Association and is sent free of charge to the members in regular standing on payment of two dollars for each, appears to give satisfaction. We recommend that the contract with the Macmillan Company be renewed for the year 1905.

R. S. Woodward,
J. McK. Cattell,
Carroll D. Wright,
L. O. Howard,
L. K. Gilbert.

AMENDMENTS.

The following amendment to the Constitution which was proposed at the St. Louis Meeting, favorably acted upon by the Council and reported to the General Session, was adopted:

Amend Article 34 by the omission of the words, "On the election of any member as Fellow an additional fee of $2 shall be paid."

The proposed amendment to Article 4, line 2, to read "The members of at least one year's standing, who are professionally engaged in science and have, by their labors, aided in advancing Science" was unfavorably reported upon by the Committee on Policy.

POLICY OF THE ASSOCIATION.

The Council appointed Mr. R. S. Woodward permanent Chairman of the Committee on Policy of the Association.

The Council voted that the Committee on Policy of the Association be regarded to exercise a general executive control of the preliminary arrangements for meetings and of the publications, subject to the approval of the Council.

The Committee on Policy of the Association reported the following resolutions which were adopted:

"That the Permanent Secretary be authorized to offer sets of back volumes of the Proceedings to libraries which shall be approved by the Committee of the Association appointed by the President."

"That the publishers of Science be requested to announce prominently that cut copies will be sent to members who request it."

That the Committee recommends as members, and if they become members, nominates as follows, members of the National Scientific Societies not now members of the Association in cases in which the National Scientific Society has a qualification for membership equal to that of the qualifications of the Association for Fellowship. The following Societies are accepted as having such qualifications:

The American Society of Naturalists.
The American Philosophical Society.
The American Academy of Arts and Sciences.
The American Anthropological Association.
The Association of American Anatomists.
The Association of American Physicians.
The Association of Pathologists and Bacteriologists.
The Astronomical and Astrophysical Society of America.
The Association of Economic Entomologists.
The Botanical Society of America.
The Geological Society of America.
The American Mathematical Society.
Active members of the American Ornithological Union.
The American Philosophical Association.

The American Physical Society.
The American Physiological Society.
The American Psychological Association.
The American Society of Bacteriologists.
The Society of Plant Morphology and Physiology.
The American Zoological Society.

The following resolution was referred to the Committee on Policy of the Association.

Resolved, that the Year Book of this Association be hereafter sent, bound, to such members as may notify the Permanent Secretary of their desire to receive it in that form. Binding to be in cloth or boards, as the Treasurer and Secretary may think proper.

REPORT ON RESOLUTIONS.

The following resolutions were proposed by C. M. Woodward and adopted at the meeting of the General Session held on Saturday, December 31, 1904.

Resolved, that we heartily thank the officers of the large variety of institutions of Philadelphia, which have opened their doors to visiting delegations from this Association, whereby we have gained a more adequate knowledge of the enterprise, resources and beauty of this great city. While it is impossible to do justice to all, we must not omit to mention:—

The Academy of Natural Science.
The Biological Garden.
The Filtration Works at Belmont.
The Baldwin Locomotive Works.
The United States Mint.
The Franklin Institute.
The High Pressure Fire Service Plant.
The Philadelphia Electric Power Station.
The League Island Navy Yard.
The Philadelphia Subway.

Resolved, that the thanks of this Association are due and are hereby tendered to the Provost and Corps of Professors and Instructors of the University of Pennsylvania for the use of rooms and all the conveniences for comfort placed at our disposal, and for the constant personal attention we have received at their hands. We have abundant evidence that science and the love of science make all men brothers, and that advancement comes through co-operation cordial. We especially recognize the gracious courtesy of Mr. and Mrs. Harrison, as shown in the reception, and the lavish hospitality of the University in providing lunch in the gymnasium hall.

The Local Committee has met every want, and we name with special gratitude, Provost Harrison, Prof. Edgar F. Smith, and the ladies of the Reception Committee.

General Committee.

At the meeting of the General Committee, Friday evening, it was decided to hold the next meeting in New Orleans, the work of the Association to begin Friday, December 29th, 1905. Boston was recommended as the place of the meeting in 1906.

The following officers were elected for the New Orleans meeting:

President—Prof. C. M. Woodward, St. Louis, Mo.

Vice-Presidents:

Section A—Prof. W. S. Eichelberger, Washington, D. C.

Section B—Prof. Henry Crew, Evanston, Ill.

Section C—Prof. Chas. F. Maybery, Cleveland, Ohio.

Section D—Pres. F. W. McNair, Houghton, Mich.

Section E—Prof. Wm. North Rice, Middletown, Conn.

Section F—Prof. H. B. Ward, Lincoln, Neb.

Section G—Dr. Erwin F. Smith, Washington, D. C.

Section H—Dr. Geo. Grant McCurdy, New Haven, Conn.

Section I—Prof. Irving Fisher, New Haven, Conn.

Section K—Prof. Wm. T. Sedgwick, Boston, Mass.

Permanent Secretary—Dr. L. O. Howard was elected for a period of five years beginning August, 1905.

General Secretary—Prof. C. A. Waldo, Lafayette, Ind.

Secretary of Council—Prof. John F. Hayford, Washington, D. C.

Secretary—Section K—Dr. Wm. J. Geis, New York, N. Y.

Charles S. Howe,
General Secretary.

Report of the Treasurer for 1904.

In compliance with Article 15 of the Constitution, and by direction o the Council, I have the honor to make the following report, showing receipts, disbursements, and disposition of funds of the Association for the year ending December 31, 1904.

Receipts have come into the keeping of the Treasurer from interest on funds deposited in savings banks and with the U. S. Trust Company. The aggregate of this interest is $494.31.

Disbursements made in accordance with the directions of the Council amount to $360.00.

The total amount of funds of the Association deposited in banks and with the U. S. Trust Company, and subject to the order of the Treasurer, December 31, 1904, is $15,455.07.

The details of receipts, disbursements, and disposition of funds are shown in the following itemized statement.

Dated April 1, 1905.

THE TREASURER IN ACCOUNT WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

1904.	DR.		
	To balance from last account		$15,320.76
Dec. 31.	To amount of interest received on funds deposited in savings banks and with U. S. Trust Company as follows:		
	From Cambridge Savings Bank, Cambridge, Mass..........................	$ 35.72	
	From Emigrant Industrial Savings Bank, New York, N. Y.	119.78	
	From Metropolitan Savings Bank, New York, N. Y.	102.49	
	From Institution for the Savings of Merchants' Clerks, New York, N. Y.	101.32	
	From U. S. Trust Company, New York, N. Y................................	135.00	
			494.31
	Total		$15,815.07

THE TREASURER IN ACCOUNT WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

1904.	CR.		
Jan. 11.	By grant paid D. T. MacDougal, of committee on relations of plants to climate		$ 75.00
Jan. 20.	By grant paid Jas. McK. Cattell, of committee on anthropometry		50.00
Jan. 21.	By grant paid D. B. Brace, of committee on velocity of light		75.00
Jan. 26.	By grant paid Charles Baskerville, of committee on atomic weight of thorium		100.00
April 30.	By grant paid W. D. Bancroft, of committee on electrochemistry		60.00
Dec. 31.	By cash on deposit as follows:		
	In Cambridge Savings Bank, Cambridge, Mass.	$1,047.92	
	In Emigrant Industrial Savings Bank, New York, N. Y.	3,109.20	
	In Metropolitan Savings Bank, New York, N. Y.	3,006.43	
	In Institution for the Savings of Merchants' Clerks, New York, N. Y.	2,971.45	
	In U. S. Trust Company, New York, N. Y.	4,635.00	
	In Fifth Avenue Bank, New York, N. Y.	685.07	
			15,455.07
	Total		$15,815.07

I certify that the foregoing account is correctly cast and properly vouched.

EMORY MCCLINTOCK,
Auditor.

April 7, 1905.

Report of the Permanent Secretary.

The matters heretofore referred to in the report of the Permanent Secretary, in so far as they relate to the annual meeting, have been covered in the report of the executive proceedings prepared by the General Secretary, and duplication is avoided by omitting them under the present head.

The following is a comparative statement of the roll of members as printed in the Washington and St. Louis volumes and in the present volume:

	Washington.	*St. Louis.*	*Philadelphia.*
Surviving founders	3	3	2
Living patrons			2
Living honorary fellows	3	3	3
Fellows	1,197	1,255	1,351
Members	2,787	2,864	2,963
Totals	3,992	4,127	4,321
Honorary life fellows (founders) included in the above	3	3	2

L. O. Howard,
Permanent Secretary.

L. O. HOWARD, PERMANENT SECRETARY, IN
TION FOR THE ADVANCE-

From January 1, 1904, *to*

DR.

To balance from last account		$12,736.15
Admission fees	$1,285.00	
Annual dues for 1904	3,444.50	
Annual dues for 1905	6,769.00	
Annual dues for previous years	138.00	
Associate fees	24.00	
Fellowship fees	142.00	
Life membership fees	230.00	
		12,032.50
Publications	10.70	
Binding	15.50	
Miscellaneous receipts	75.38	
Interest	101.78	
		203.36
		$24.972.01

ACCOUNT WITH THE AMERICAN ASSOCIA-
MENT OF SCIENCE.

December 31, 1904.

CR.

By publications.		
To publishers SCIENCE	$6,972.04	
On acct. Vol. 53	625.00	
Preliminary announcement	154.85	
St. Louis pamphlet	194.60	
		$7,946.49
By expenses St. Louis and Philadelphia meetings.		
Secretaries of sections, etc.	474.85	
Stenographers	55.25	
Other expenses	30.17	
		560.27
By general expenses, including propaganda.		
Postage	1,107.52	
Express	462.46	
Stationery, circulars, author's extras, etc.	417.06	
Extra clerical help	61.17	
Telegrams and small miscellaneous expenses	7.91	
		2,056.12
By salaries.		
Permanent Secretary	1,500.00	
Assistant Secretary	750.00	
Assistant Secretary	250.00	
		2,500.00
By miscellaneous disbursements.		
Overpaid dues returned	23.00	
		23.00
By balance to new account		11,886.13
		$24,972.01

I hereby certify that I have examined this account and that it is correctly cast and properly vouched for, and that the balance was on deposit in Washington as follows: Citizens National Bank (Jan. 11, 1904), $1.05; National Safe Deposit Trust Co. (Jan. 1, 1905), $1,594.48; American Security and Trust Co. (Jan. 4, 1905), $3,572.13; and American National Bank (Jan. 4, 1905), $6,718.47; in all, $11,886.13.

G. K. GILBERT, *Auditor.*

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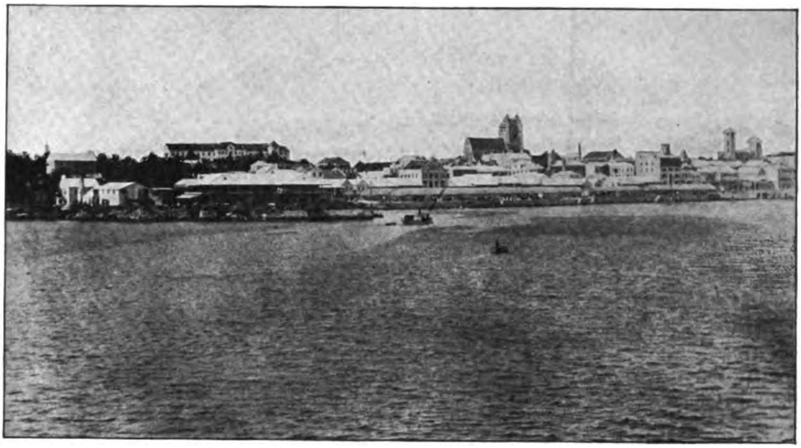

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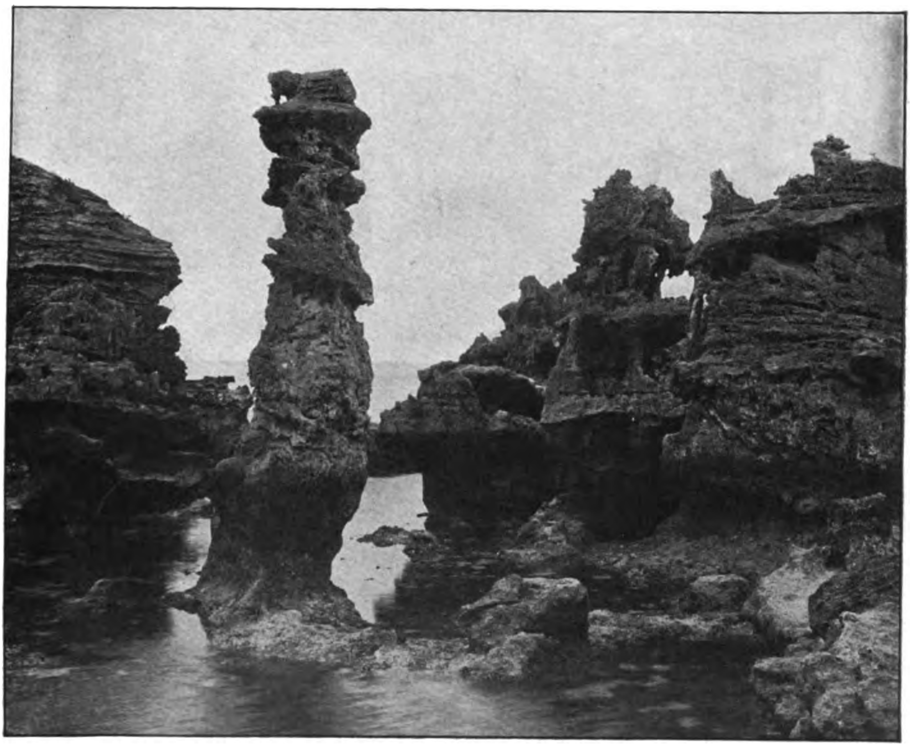

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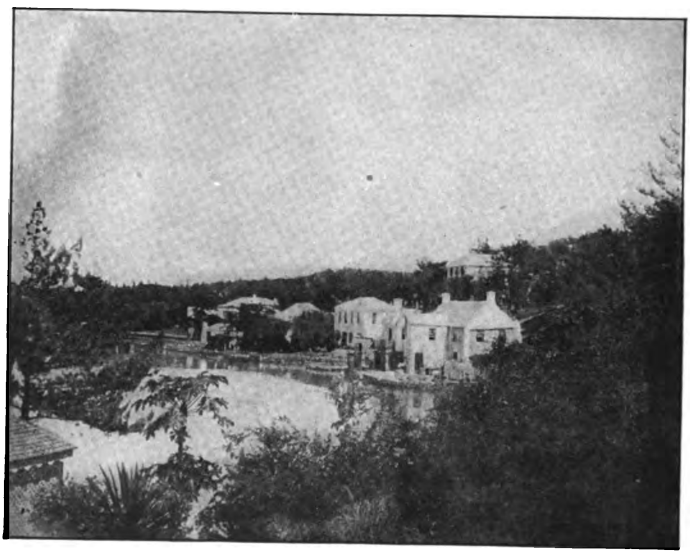

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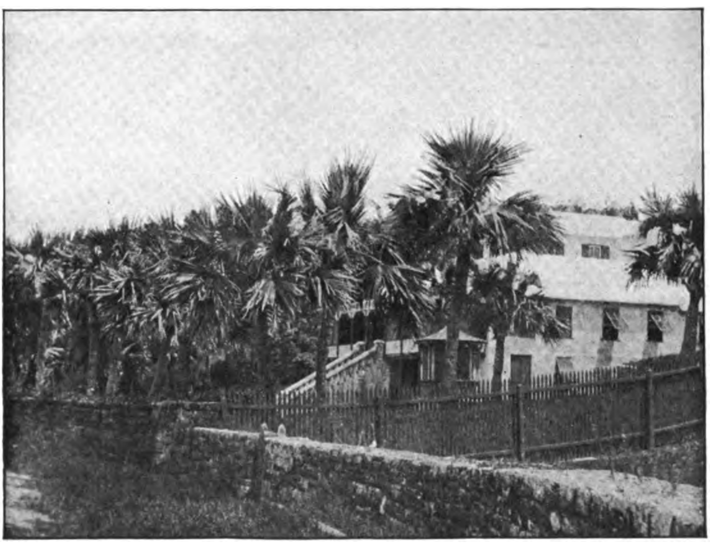

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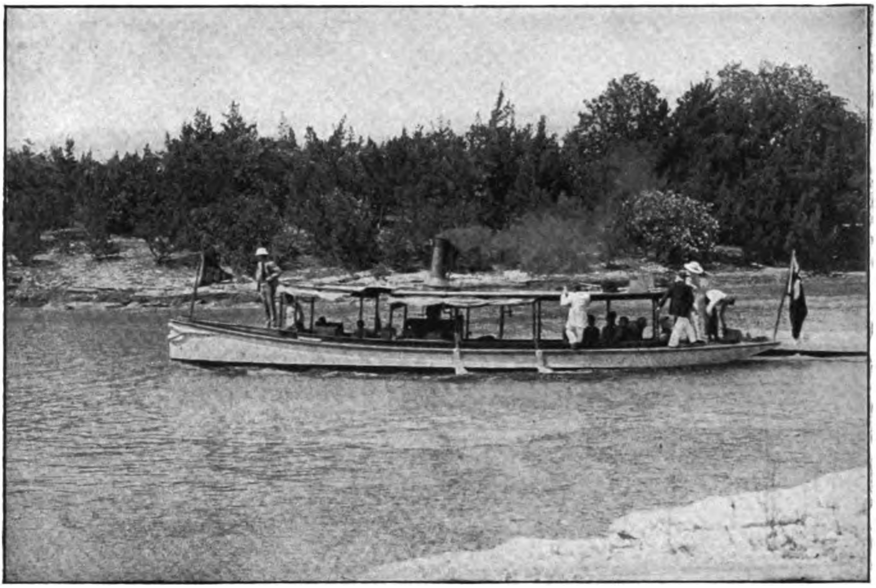

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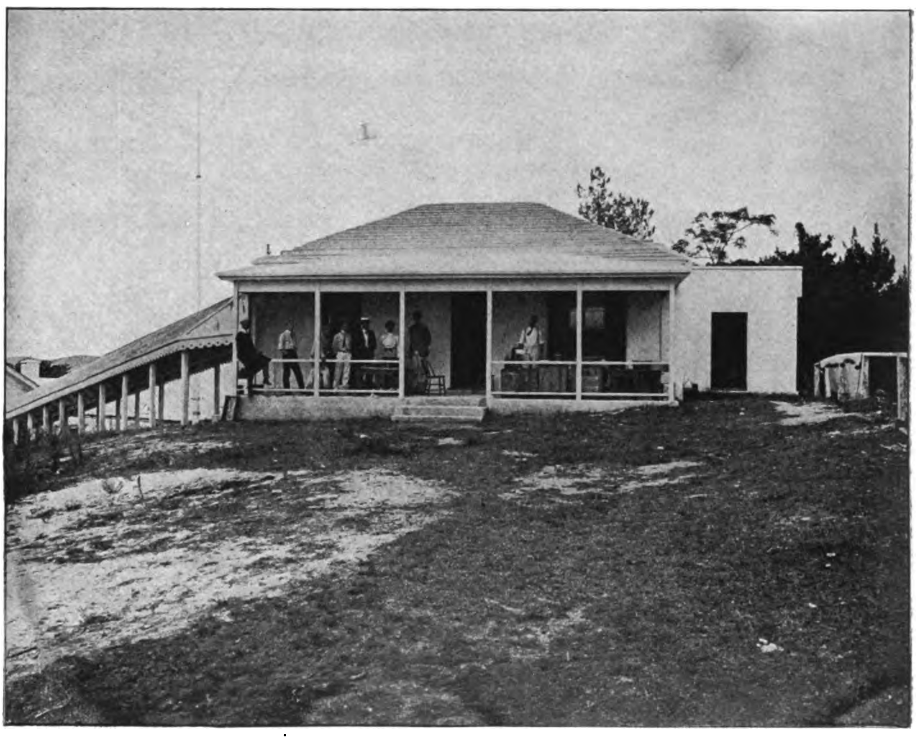

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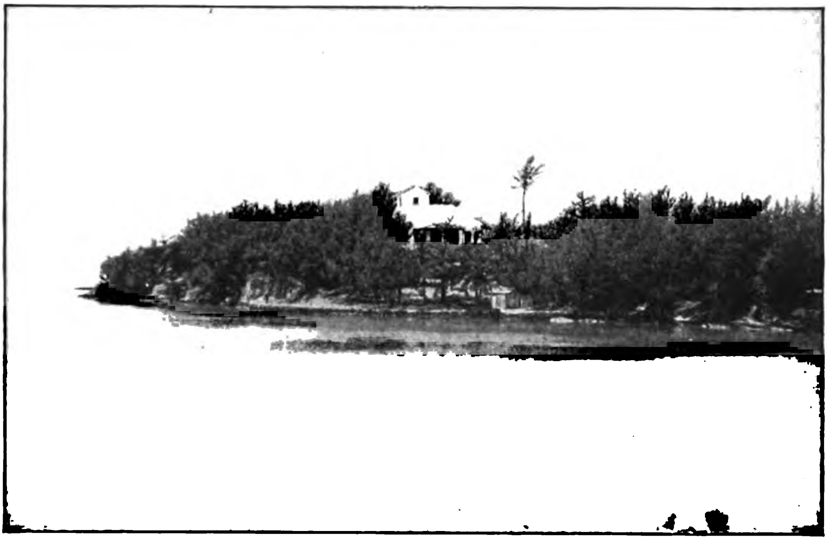

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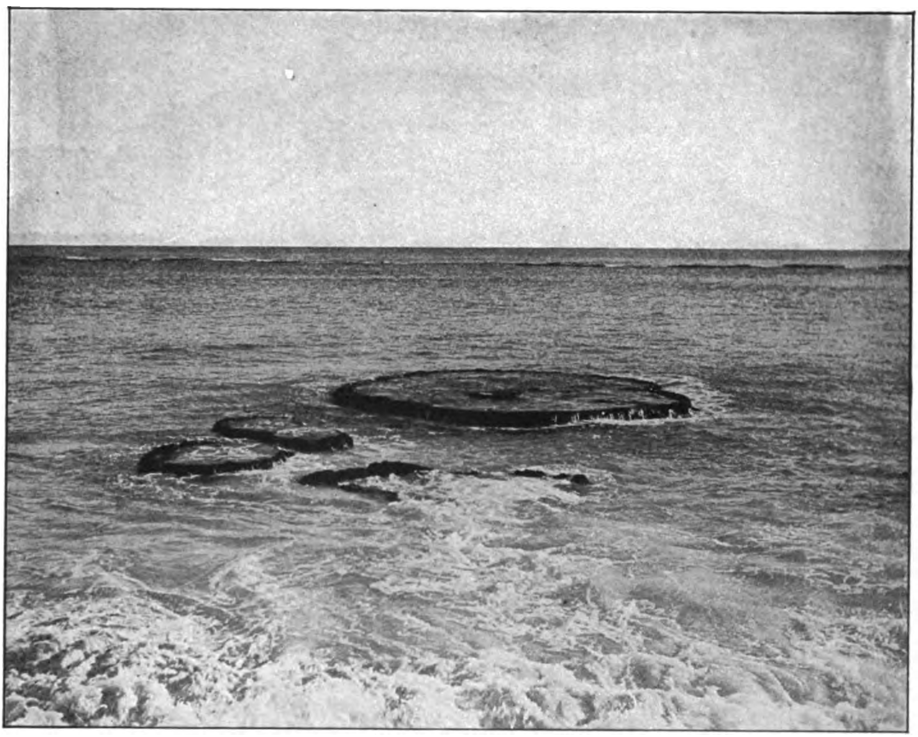

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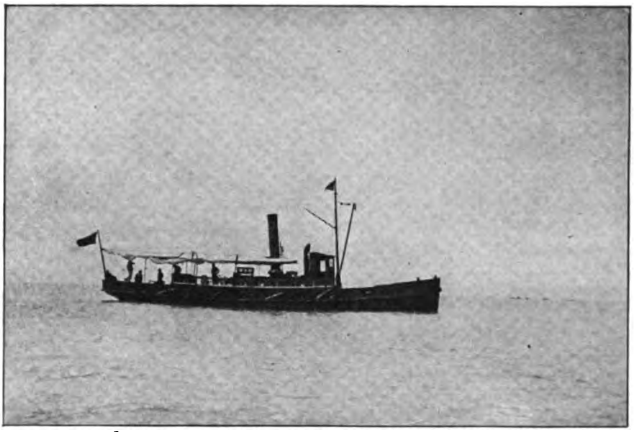

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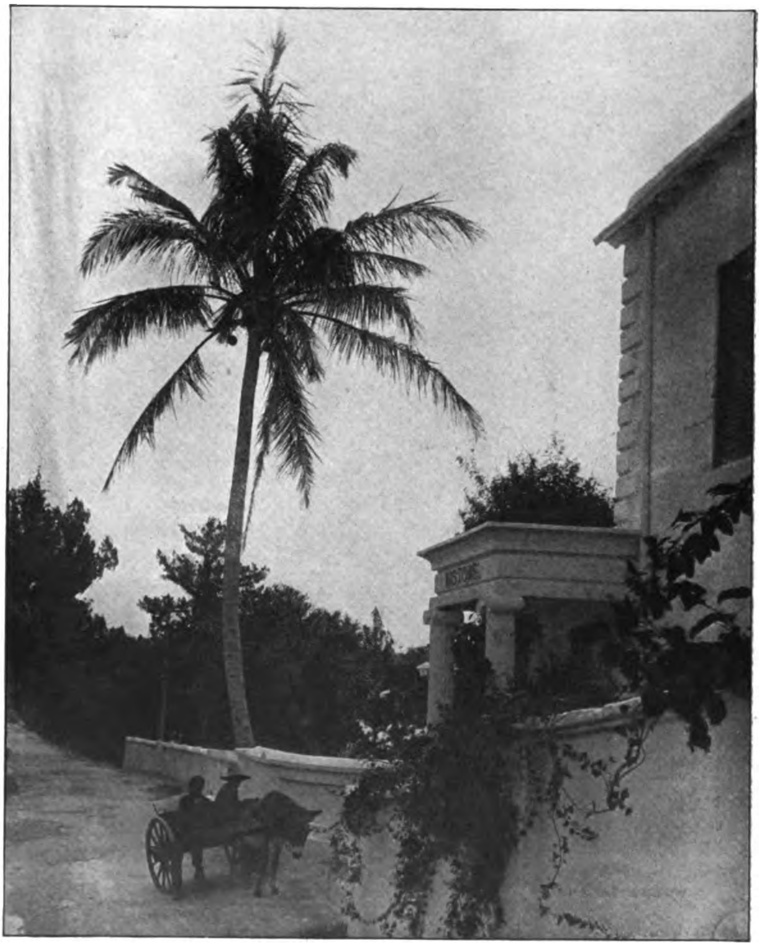

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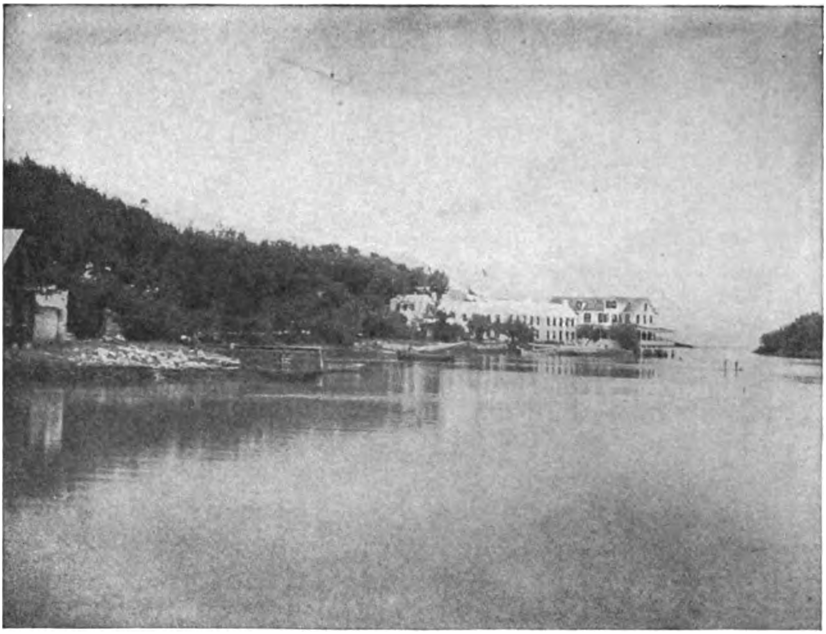

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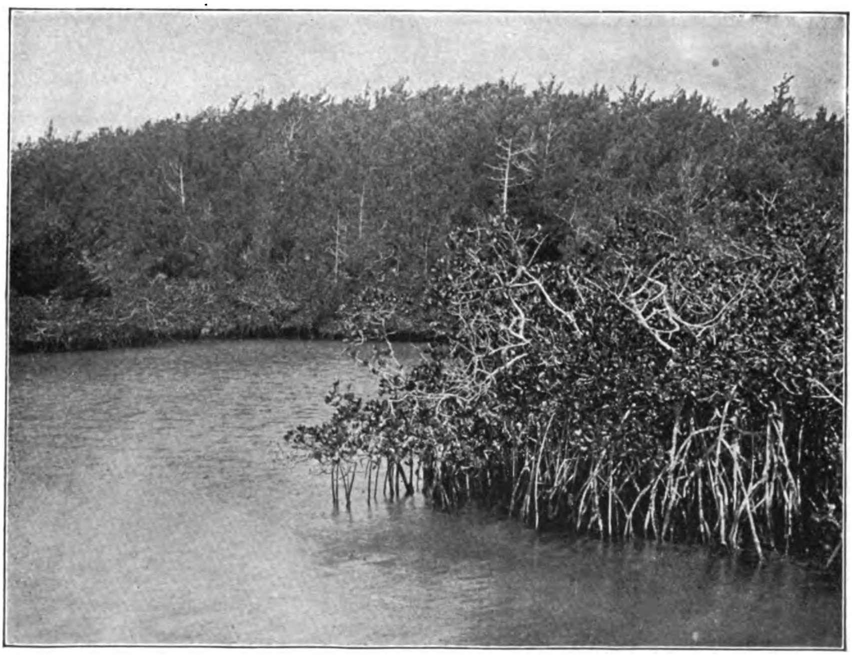

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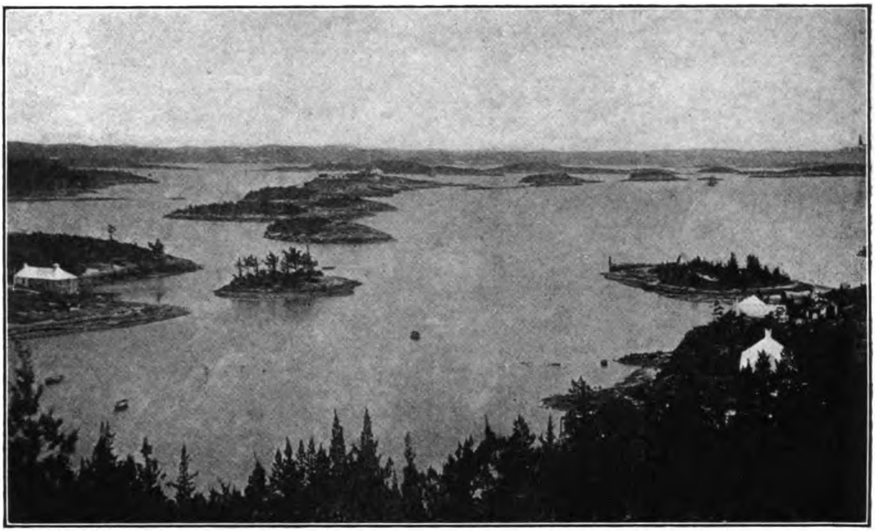

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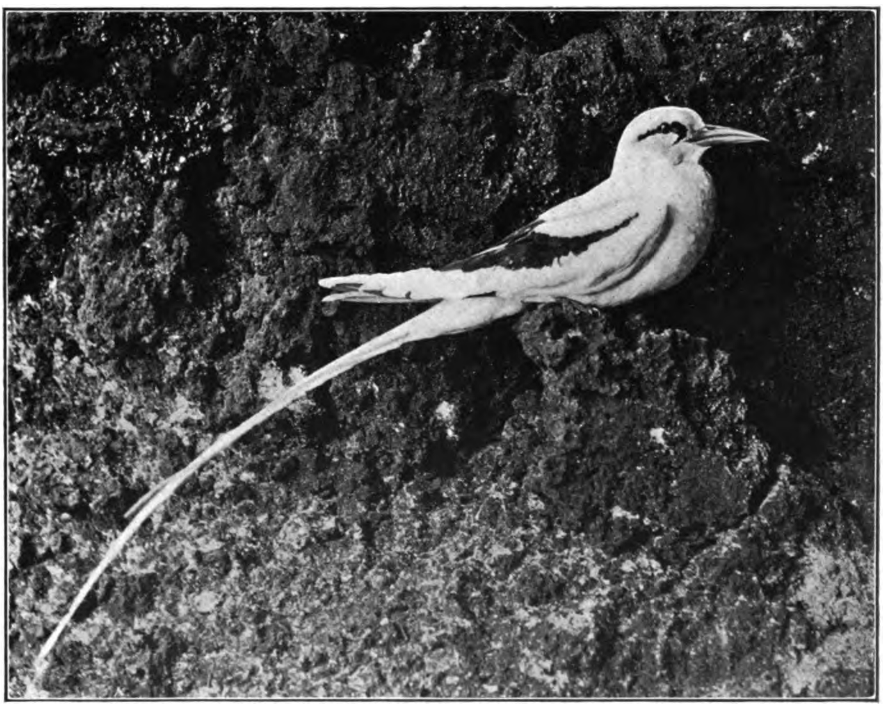

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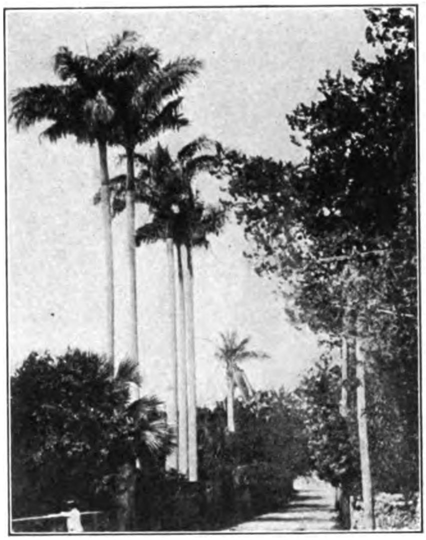

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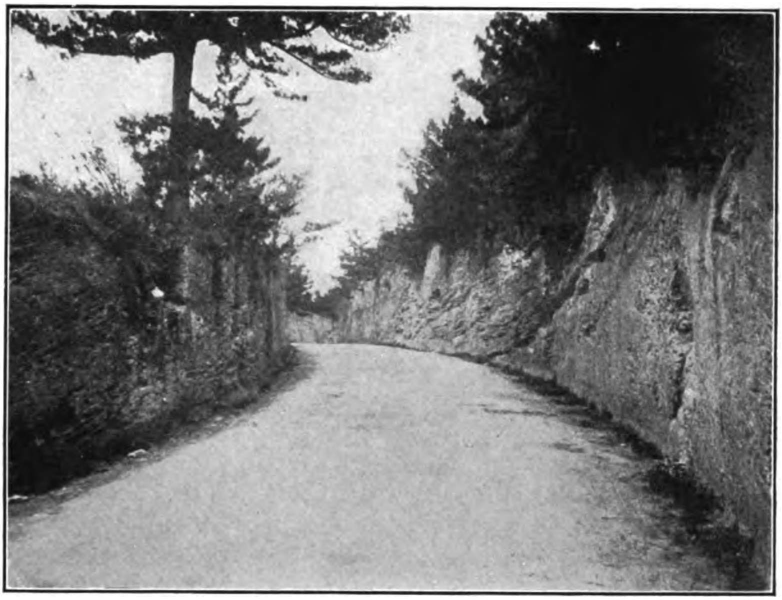

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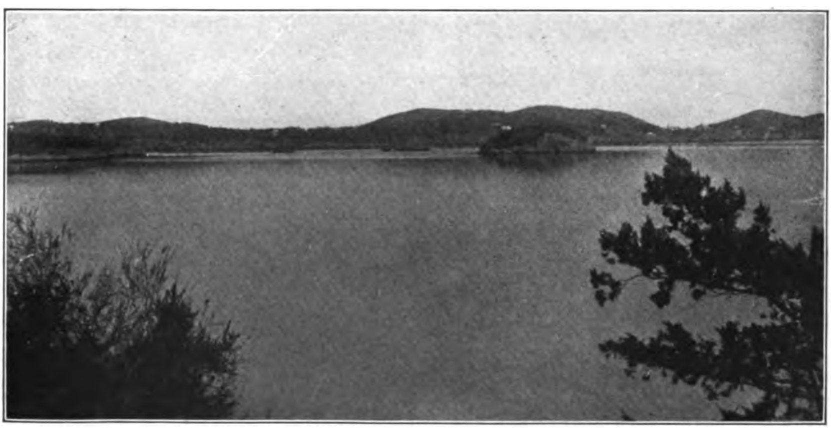

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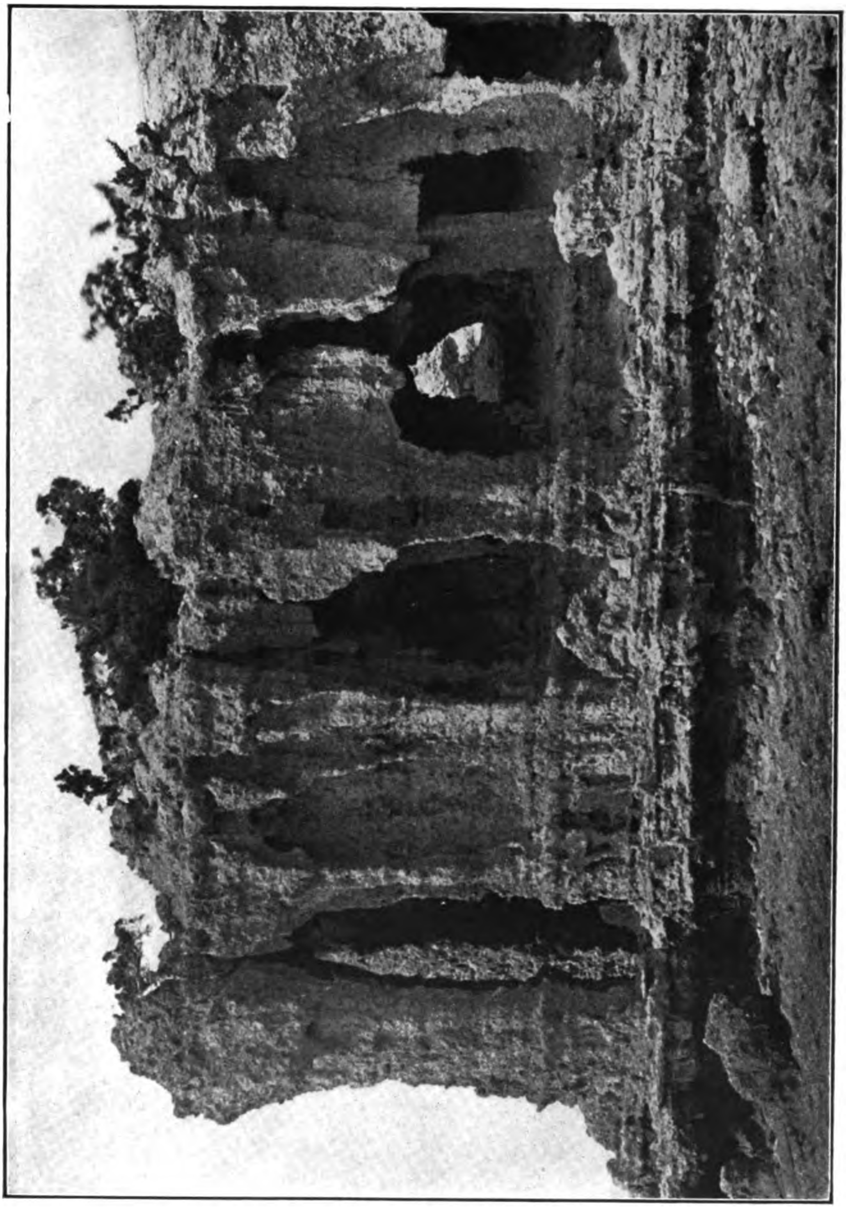

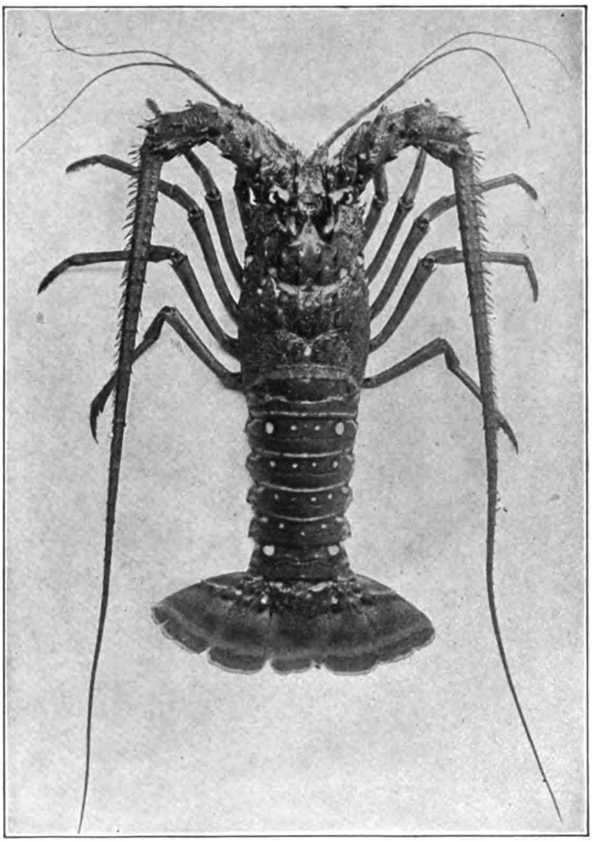

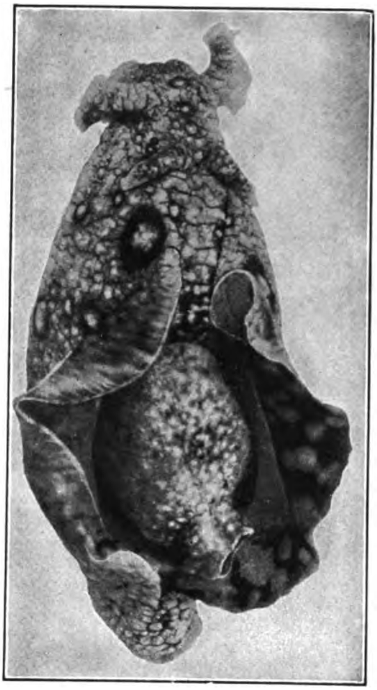

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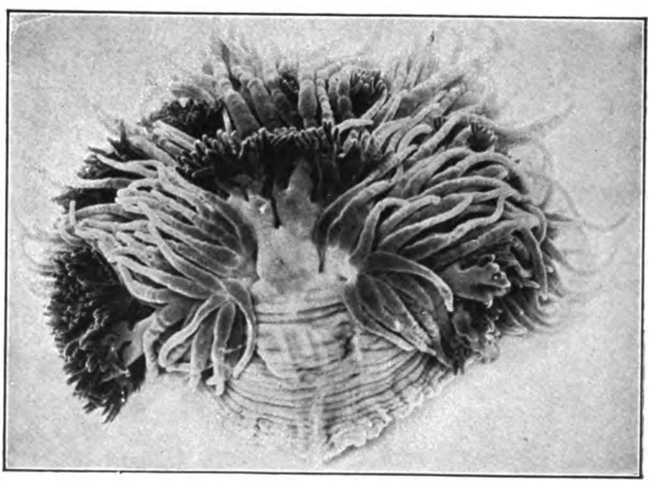

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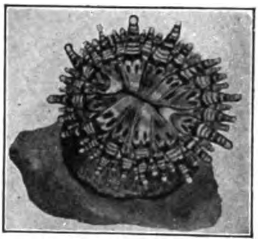

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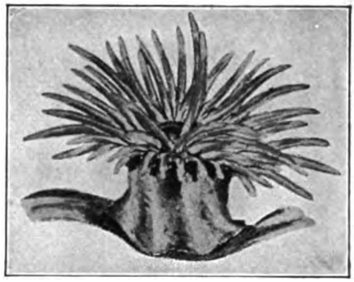

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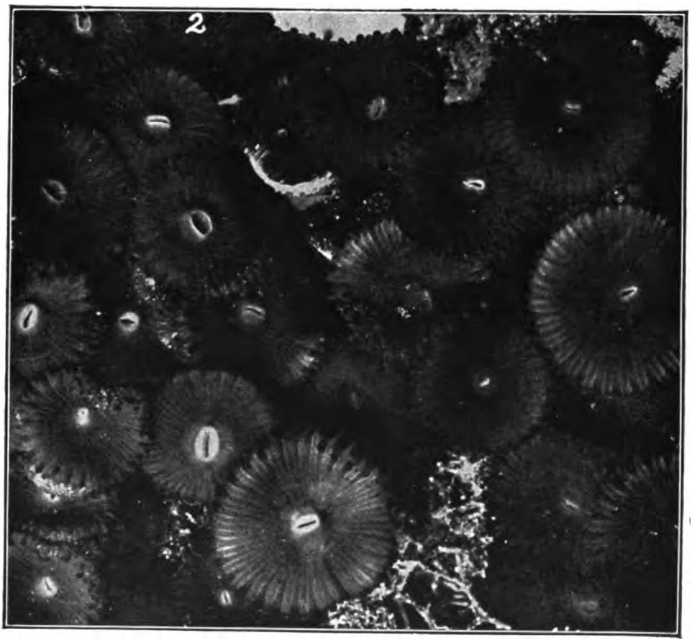

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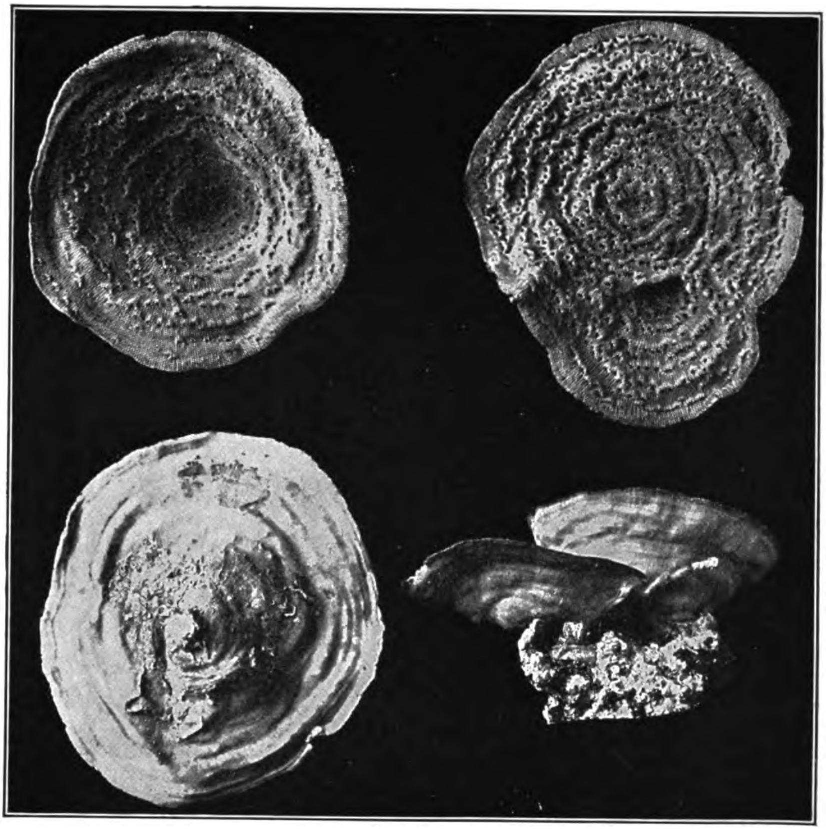

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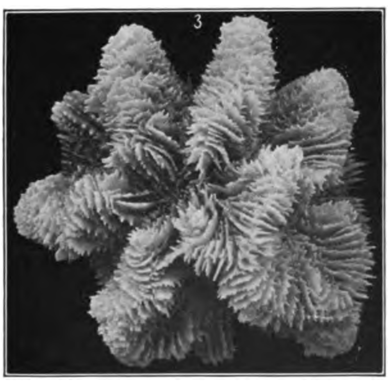

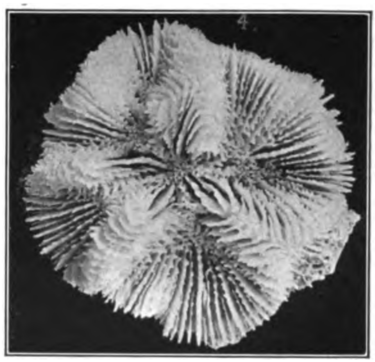

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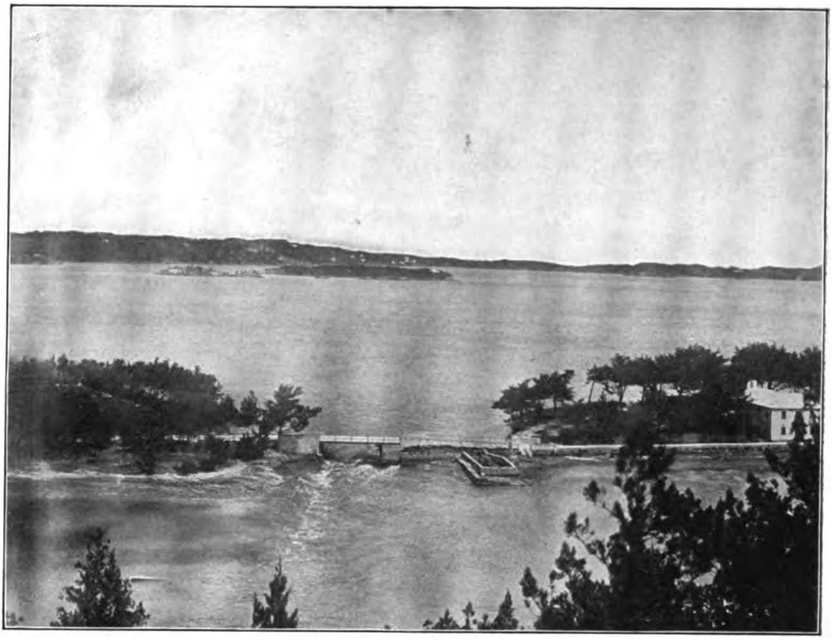

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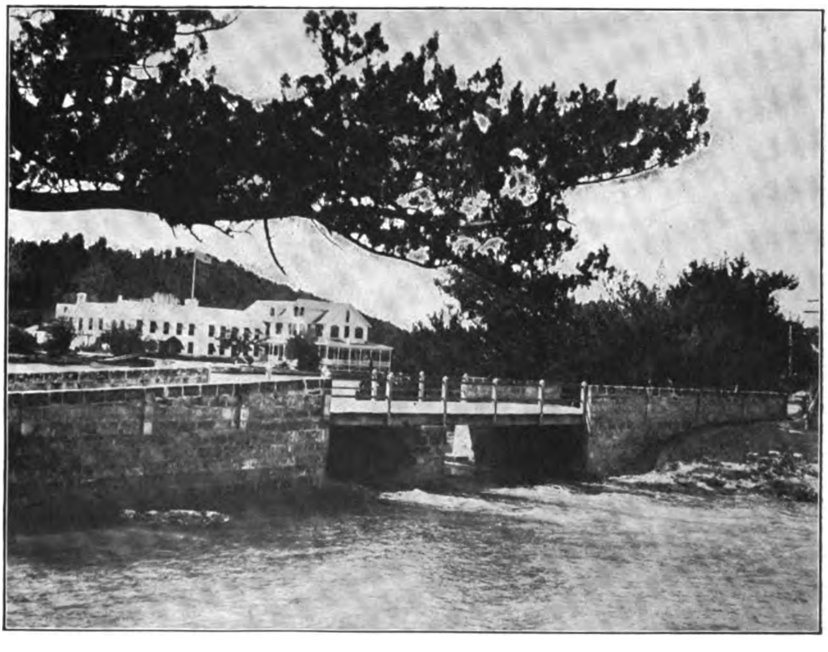

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